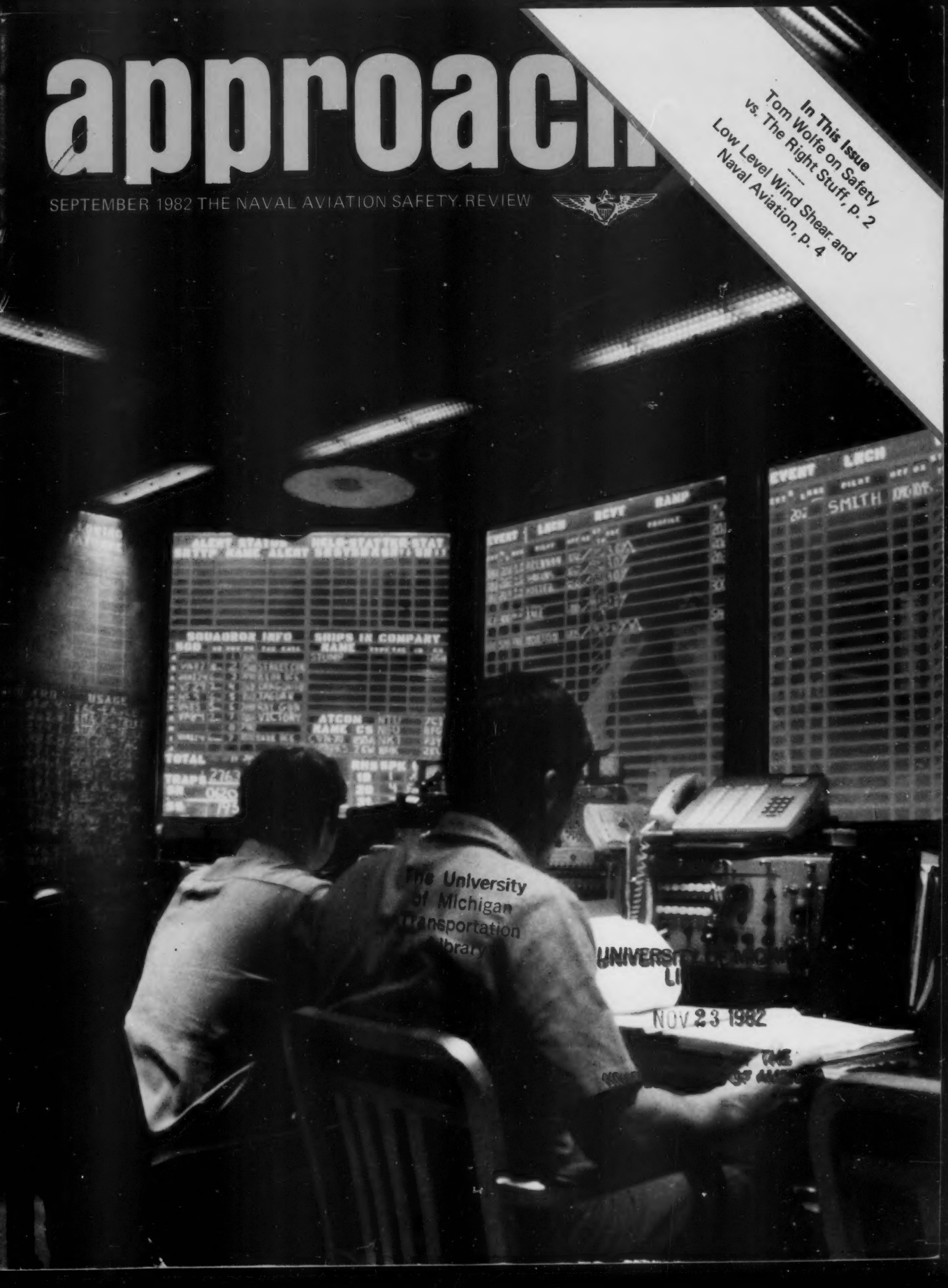
approach

SEPTEMBER 1982 THE NAVAL AVIATION SAFETY REVIEW

In This Issue

Tom Wolfe on Safety vs. The Right Stuff, p. 2

Low Level Wind Shear and Naval Aviation, p. 4



The University of Michigan Transportation Library

NOV 23 1982

A wind shear story

Wind shear. It was all over the newspapers. And here was a classic, black example of a mature thunderstorm menacing the end of the runway. I could almost imagine the invisible lines of heavy rain where the downburst was.

Nobody's going to be flying today, I thought as I drove past the runway on my way to the Navy Exchange. Then I heard the sound of an aircraft taking off! An E-2 was climbing straight into the downburst area at full power. The *Hummer* all but disappeared behind some hellblack clouds and lightning, and then I remembered the rumour I'd been hearing lately: *military aircraft are not affected by wind shear*. What a relief! And sure enough, the *Hummer* didn't crash but escaped with a high angle-of-bank maneuver at midfield.

Could the rumour be true?

This was rather an amazing meteorological phenomenon, but I was in a hurry to get to the Exchange, so I stopped worrying about it.

Then LCDR Joe Towers, a former airline pilot now flying with VR-57, started bothering me with an article about this wind shear business. He kept reasoning that, because we in Naval Aviation also fly airfoils, wind shear can affect us too! Phone calls, letters – he wouldn't let up, so we're printing his 8-page feature (page 4) to get rid of him. We hope it gives everyone a good laugh.

LT Colin Sargent

D202.13:28/3

374-A

approach

Vol. 28 No. 3
NAVAIR 00-75-510

Status boards highlight Air Operations on the USS CARL VINSON. Photo by PH3 Steven P. Webb.

Safety vs. The Right Stuff 2
By Tom Wolfe. How do they fit into your flying style?

Low Level Wind Shear and Naval Aviation 4
By LCDR Joe Towers. The dangers wind shear has for you.

Look at These Burbles! 12
By Richard J. Perrelli. Wind made visible over flight decks.

Get Us Out! Get Us Out! 30
By LT Colin Sargent. You're in the cockpit for this night F-14 ejection.

Forever Is a Long Way to Fall 16
By Russ Forbush

Air Breaks 18

Nightmare 20
By LCDR Pete Blackwood

Duet With a Hangman 22
By Maj Mark Mallett, USMC

A Shepherd Gets Fleeced 24
By Harry "Bud" Baer

Bravo Zulu 26

The Last Words on Motherhood 28
By CDR Dan Ryder

RADM T. C. Steele, Commander, Naval Safety Center
CAPT S. P. Dunlap, Director, Aviation Safety Programs
CDR C. E. McCaskill, Head, Safety Publications
LT Colin W. Sargent, Editor

Robert Trotter, Art Director
Richard A. Eldridge, Writer
Russ T. Forbush, Helicopter Writer
Joe Casto, Writer
Blake Rader, Illustrator
Jack LaBar, Illustrator
Frank L. Smith, Graphics
PH2 Ronald K. Bellenot, Photographer
PH3 Steven P. Webb, Photographer
Catherine M. Wizieck, Editorial Assistant
Patricia A. Kinter, Type Composer
Robin C. Miller, Type Composer
Nancy Hupman, Publications Manager
Doris Sumner, Circulation

Contents should not be considered as regulations, orders, or directives and may not be construed as incriminating under Art. 31, UCMJ. Views of guest-written articles are not necessarily those of NAVSAFECEN. Photos are Official Navy or as credited. Photographs used have no strict relationship to the text. Official distribution handled by NAVSAFECEN, Safety Pub. Dept., NAS Norfolk, VA 23511. Phone: (804) 444-1321; Autovon 690-1321. Printed in accordance with Dept. of the Navy Publications and Printing Regulations, NAVEXOS P-35. Library of Congress Catalog No. 57 60020.

Tom Wolfe on Safety vs. The Right Stuff

In what measure do safety and THE RIGHT STUFF fit into your flying style? Is it the correct measure? We asked Tom Wolfe to describe the relationship he sees between safety and THE RIGHT STUFF, and he was kind enough to do so (see next page).

If these two pages make you consider for yourself the relative merits of safety and THE RIGHT STUFF, they'll have more than served their purpose!

Dear Lt. Sargent,

One of the things that struck me in talking to pilots was that there is a curiously safety-minded attitude built into the code I have called The Right Stuff. And it is this: no true believer in the code can accept the notion that his sublime and righteous stuff can be extinguished by anything so banal as an accident – i.e., a chance mishap against which his will and skill are powerless. So he concludes: "There are no such things as accidents. There are only stupid, inept, or panicky pilots." ("Therefore, a fellow like myself, with the right stuff, is immune to this business of accidents.") A corollary is that the truly best pilot is supremely responsible for every element of every flight, including the most mechanical safety checks. An oxygen hose connection separates and the pilot of an F-4 passes out from anoxia at 20,000 feet and crashes into the Chesapeake Bay and dies, and his comrades – or the righteous among them – say: "The idiot! How could anybody go up in an F-4 without checking his oxygen connections?"

I'm not saying that the logic of all this is unassailable, but there does seem to be a good healthy self-preserving streak of safety-consciousness in it.

I would say that, in any case, the code is necessary to all military pilots, now and in the future, whether they fly safely or not. The simple fact is, there are far safer ways of making one's way through this Trough of Mortal Error called life. But there are also far duller and more pointless ways.

Please excuse this handwritten reply. I am out here in the country, far from such menaces to mental safety as the typewriter and the Compugraphic console.

Best wishes

Tom Wolfe

TOM WOLFE
SOUTHAMPTON
NEW YORK
JUNE THE
TWENTY-
FIFTH 1982

LOW LEVEL WIND AND NAVAL

BLUEBIRD 609, configured for landing, was on a precision final to Runway 27L at Atlanta International Airport. A localized heavy rainshower with associated wind shears existed along the final approach course. The crew had the field in sight. Flying in light rain and light turbulence, the aircraft experienced fluctuations in airspeed. Heavy rain and moderate turbulence shook the liner at 1,000 feet AGL. Indicated airspeed began to fluctuate from 135 to 120 KIAS, then increased to 140 KIAS. Suddenly, indicated airspeed began to decay rapidly and the rate of descent increased to 1,000 fpm. The pilots began missed approach procedures at 800 feet AGL. They rotated the aircraft to 10 degrees nose up while setting the thrust levers for go-around power. The pitch correction and added thrust had no effect. Descent rate increased to 1,500 fpm and then to 2,000 fpm. Somewhat alarmed, they pulled the nose back to 15 degrees pitch attitude while advancing the thrust levers to the forward stops, resulting in overspeed and overtemps on all engines.

At 500 to 600 feet AGL, with an indicated airspeed between 105 to 100 KIAS, the stall warning system activated. The aircraft was now well below glide slope. At this point, the instantaneous vertical velocity indicator (IVVI) registered a 2,200 fpm rate of descent. Finally, at 375 feet AGL, the aircraft began to accelerate, the descent was arrested, and a climbout was begun.

In this incident, the flight crew's awareness of the wind shear phenomenon, combined with the successful execution of certain tactics, undoubtedly prevented a major catastrophe.

SHEAR AVIATION

By LCDR J. F. Towers, USNR
VR-57

The flight crew delayed the aircraft's descent and managed to keep it airborne while traversing the downburst area of a nearby thunderstorm. Had the pilot lowered the aircraft's nose in an attempt to recover his normal approach speed, the aircraft would have impacted the ground or the recovery would have been made at a much lower altitude – not much of a margin for comfort when you're already close to the terrain.

Frontal passage, with its share of unstable air, sets the stage for a multitude of thunderstorms. One of the byproducts associated with thunderstorms is the hazardous phenomenon of low level wind shear.

There are a few myths I'd like to gently explode with this article. *First of all, contrary to widespread rumors, naval aircraft are vulnerable to the phenomenon of wind shear.* I feel that many naval aircraft mishaps may have occurred because wind shear was a contributory factor. Due to inconclusive analysis and evidence, however, none of these mishaps are listed under a wind-shear cause classification. Since the dawn of time, wind shear has existed in nature. Therefore, it's highly unlikely that naval aircraft have been spared from this devastating phenomenon. Perhaps wind shear mishaps have been obscurely hidden under accidents classified as pilot error or unknown (where the mishap cause is "laid at God's doorstep"). Mishaps with gusting and shifting winds, thunderstorms in the vicinity, heavy rainfall, and similar conditions would be highly suspect. In any event, the fact remains that low level wind shear does exist. It is extremely hazardous, and it has the

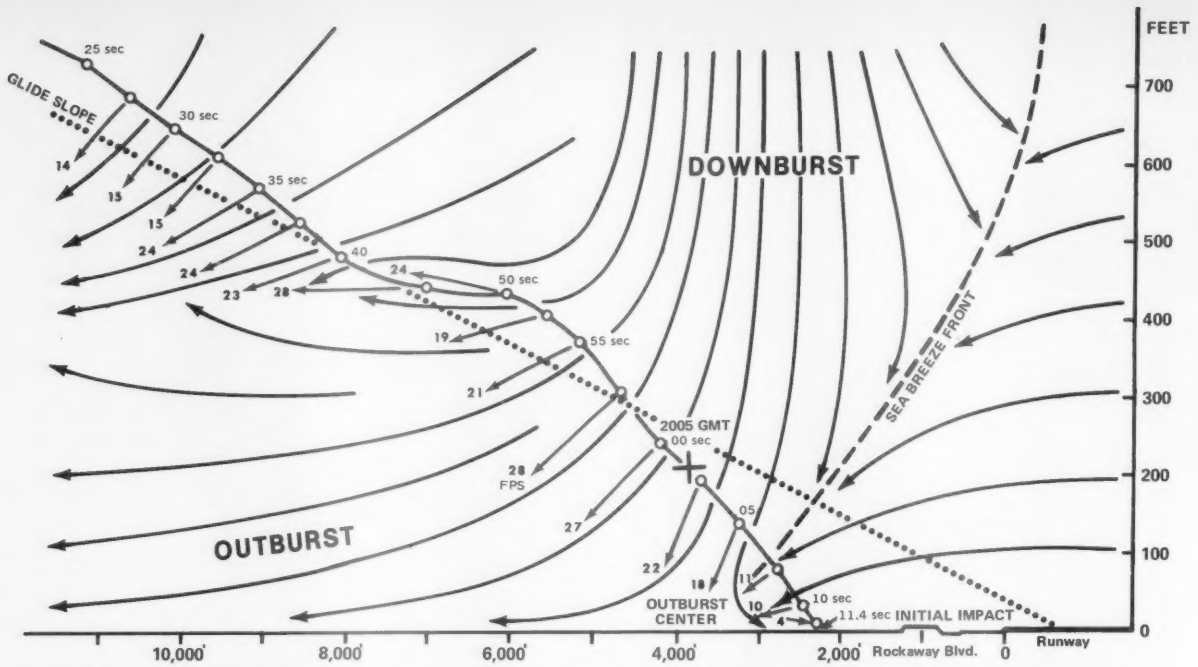


Figure 1 shows the reconstruction of the flight profile and prevailing gust patterns that existed at the time of an actual wind shear mishap. Unfamiliarity with this unusual phenomenon and "normal pilot responses" contributed to this catastrophe.

potential to destroy virtually any aircraft in the Navy's inventory if not properly dealt with by the pilot, the human element in control.

6 **Navy tactical aircraft,** fortunately, have some definite operating characteristic advantages in wind shear conditions. Their higher thrust-to-weight ratio can provide for fast acceleration and a quick return to safe flight. However, some very definite disadvantages also exist. The flying of an optimum TACAIR angle-of-attack approach provides for a relatively small margin above stall (approximately 10 percent). An abrupt loss of 20 to 30 KIAS during a shear situation has the potential for placing the aircraft in an immediate stall with very little altitude for recovery.

Compound this situation with throttles at a reduced setting, a high drag count, an abnormally high rate of descent, and a relatively thin swept-wing, and an *extremis* situation can develop. Furthermore, there exists the possibility that the angle-of-attack reading could fluctuate erratically and provide information that could be misleading when not cross-referenced with airspeed, particularly under severe and rapidly changing shear conditions.

Multiengine reciprocating and turboprop aircraft also have some distinct operating advantages. Their relatively thick, straight, high-lift airfoil is one such characteristic. The application of instantaneous maximum power can increase airflow over the wings of prop aircraft. This propwash can substantially reduce stall speed and generate additional lift. However, their low power-to-weight ratio cannot compete with that of their tactical counterparts.

Wind shear effects have been most frequently documented in connection with large commercial turbine aircraft because of the availability of postmishap information on their flight data recorders. Nevertheless, there exists the same mishap potential among naval aircraft when operating under similar conditions. All pilots operating naval aircraft should be aware of the deadly potential present in a severe wind shear encounter and should not be lulled into a false sense of security. The absence of recorded Class A wind shear mishaps in naval aviation should not be interpreted to mean that none have occurred.

Low level wind shear presents the most immediate danger to aircraft on landing and takeoff. Although greater velocities are possible, wind velocities in the outburst and downburst have been derived to be from 2,000 to 3,000 fpm. In its classic form, the phenomenon exists for a relatively short period. Its duration closely approximates the life cycle of the mature phase of a thunderstorm, which generally lasts an average of 15 minutes. It is primarily during the mature phase that the intense downbursts are generated. The meteorological event is usually contained within a small geographical area. Also, the wind patterns do not remain fixed over the earth, since they move with the cells creating them. Empirically-derived data reveals that the outburst front exists from ground level up to approximately 800 feet AGL and can extend out to approximately 10 nm from the cell's center.

When an aircraft encounters the outburst head-on, indi-

APPROACH (USPS 016-510) is a monthly publication published by Commander, Naval Safety Center, Norfolk, VA 23511. Subscription price is $15.00 per year; $3.75 additional for foreign mailing. Subscription requests should be directed to: Superintendent of Documents, Government Printing Office, Washington, DC 20402. Controlled circulation postage paid at Norfolk, VA.

cated airspeed rapidly increases. The higher relative airstream velocity results in an increase in dynamic pressure, which generates additional lift. Consequently, the aircraft climbs above glide slope with a faster-than-normal approach speed. This rapid increase in indicated airspeed is brief and soon traversed. Although the aircraft is not yet in *extremis*, the course of action taken at this point is critical. *I highly recommend executing a missed approach in this situation.* The normal pilot response to this high and fast condition is to reduce power and correct back to glide slope on speed. This action can have devastating consequences, as the aircraft then enters the downburst and tailwind phase.

The flight data recorder gave modern aviation its first real insight into the devastating phenomenon of thunderstorm-generated low level wind shear. The recorder inscribes on a metallic strip various flight parameters, including vertical acceleration (G), magnetic heading, indicated airspeed, altitude, and time. This information, when incorporated into the cockpit voice recorder, is often sufficient to derive such parameters as C_L, C_D, dirty or clean configuration, angle of attack, wind velocity, and other relevant factors.

Wind shear can directly affect the amount of lift being produced. Everyone remembers the good old lift equation from flight school: $L=C_LqS$. An aircraft's generation of lift increases or decreases as a function closely related to the square of the relative **airstream velocity**. Variations of the lift equation illustrate this.

$$L = C_L\, qS$$

$$L = C_L\frac{(V^2)S}{295}$$

L is lift
C_L is the coefficient of lift
q is the dynamic pressure
S is the surface area of the wing
V is the velocity of the free airstream

(RELATIVE AIRSTREAM VELOCITY)^2

$(100)^2$	=	10,000
$(110)^2$	=	12,100
$(120)^2$	=	14,400
$(130)^2$	=	16,900
$(140)^2$	=	19,600
$(150)^2$	=	22,500
$(160)^2$	=	25,600
$(170)^2$	=	28,900

The loss of airstream velocity (indicated airspeed) significantly reduces dynamic pressure. For example, the loss of indicated airspeed from 140 to 100 KIAS effectively halves the velocity squared and hence reduces the dynamic pressure by nearly 50 percent. This reduction has a considerable effect on the total amount of lift generated at any given time. A further complication develops as the aircraft travels away from the headwind and enters the downburst and tailwind areas. The resultant relative airstream decreases the angle of attack, which subsequently reduces the coefficient of lift. *This compounded reduction in both the coefficient of lift (C_L) and dynamic pressure (q) serves to severely reduce the amount of lift being generated. The net result is a significant impairment in the aircraft's ability to remain airborne.*

What do you do if you anticipate wind shear? Here are some obvious suggestions:

- Avoid taking off or landing under evident hazardous wind conditions.
- On approach and departure, avoid areas of extremely heavy rainfall with gusting and shifting winds, especially when in the vicinity of a thunder cell.

Continued

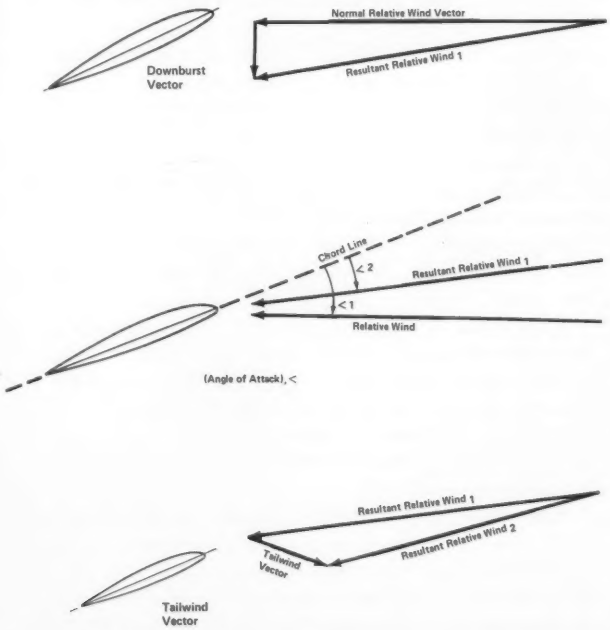


Figure 2 shows the reduction in angle of attack produced by the resultant relative wind, during the downburst and tailwind phase. Both phases further reduce the angle of attack, which also reduces the lift coefficient. The application of maximum thrust will normally serve to accelerate the aircraft mass, thereby generating a new relative wind and angle of attack that places the aircraft in a safer flight regime. Faster approach and departure speeds further diminish the detrimental effects of the downburst and tailwind vectors.

- Monitor navigation system wind (if available) and compare it with the surface wind for shear indication.
- Monitor groundspeed versus indicated airspeed for any significant shift as a measure of shear.
- Fly a faster-than-normal approach and departure to provide an increased margin above stall. For aircraft that don't use angle of attack during the approach, maintain an approach groundspeed equal to or greater than stall speed. This ensures adequate flying airspeed even when an abrupt shear is encountered.
- Consider the use of a reduced flap setting.

The wind shear operating technique section of the *AMERICAN AIRLINES OPERATING MANUAL* recommends the following procedures:

During approach, the thrust required, vertical speed, and pitch attitude, used in conjunction with the wind reported on the ground, provide an indication of potential wind shear. Look for:

– An unusually steep or shallow rate of descent required to maintain glide slope.

– An unusually high or low power setting required to maintain airspeed.

When winds are reported strong and gusty at the surface, they may be considerably stronger or weaker at altitude. If so equipped, the airspeed indicator bug should be set to accommodate possible shear and to protect against gusts. During the approach, wind shear may cause airspeed to bleed off. Proper thrust corrections must always be made promptly.

When reported surface wind would not justify an increased bug setting (for example, the tower is reporting calm wind), but wind shear is suspected, an adjustment of approach speed up to 20 knots may be used to provide an increased speed margin.

(Where applicable, do not use autothrottles if shear is suspected. Autothrottles may not add thrust aggressively enough when airspeed decreases and, conversely, may reduce thrust too far when airspeed increases.)

Stabilize the approach early – an unstabilized approach will always delay detection of wind shear.

If downdrafts or decreased performance due to wind shear are encountered during approach and landing, increase the pitch attitude as required and simultaneously apply maximum thrust. Be prepared to allow airspeed to decrease into stick shaker speed range if necessary to sustain flight or avoid ground contact. Reference speed is 30 percent above stall speed (1.3 V stall) and this buffer area above stall speed may be used to recover from a situation which demands maximum airplane performance. *(Author's note: I'll address this point in detail later in the article.)*

Many types of wind shear conditions exist, including changes of speed and/or direction as well as the possibility of vertical air movement (updrafts or downdrafts). Two specific shear conditions are described here.

Decreasing Headwind. Initial airplane reaction to a decreasing headwind (or increasing tailwind) is a drop in airspeed and a loss in altitude. It is important to promptly add thrust and increase pitch to regain airspeed and glidepath. Use whatever pitch and thrust are required. Once speed and glidepath are regained, however, prompt reduction of thrust is necessary. It will now require less thrust and a greater rate of descent to maintain the proper profile in the decreased headwind. If the initial corrections of increased thrust and pitch are not promptly removed after regaining glidepath and airspeed, a long landing at high speed will result. This is a classic overshoot situation. Be prepared for a go-around.

Increasing Headwind. Initial airplane reaction to an increasing headwind (or decreasing tailwind) is an increase in airspeed and a gain in altitude. The natural reaction to this condition is to lower the nose to regain glidepath and reduce thrust to regain airspeed. However, be prepared to raise the nose and add thrust promptly once speed and glidepath are regained. It will now require more thrust and a decreased rate of descent to maintain the proper profile in the increased headwind. Be very cautious in making the initial reductions of thrust and pitch to avoid a low-power, high-sink condition – which could lead to a correction through the glidepath from which a recovery could not be made. This could result in a gross undershoot. Be prepared for a go-around.

Caution: If wind shear is encountered on final approach, do not hesitate to go around if the approach profile and airspeed cannot be reestablished. It cannot be emphasized too strongly that a go-around is often the professional pilot's best course of action.

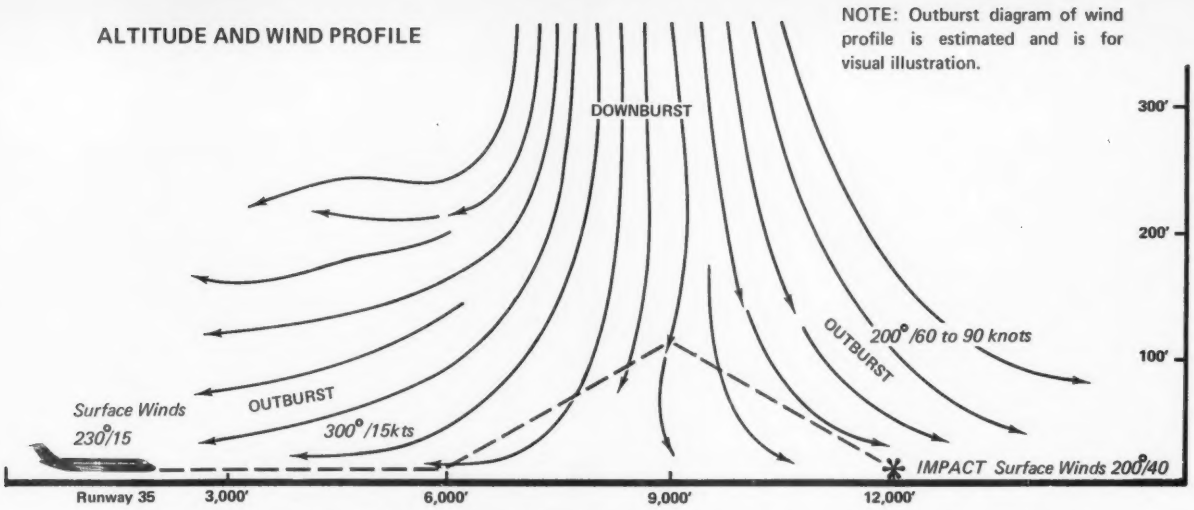
If appropriate, pilots may wish to consider holding or diverting to avoid shear conditions.

During takeoff, if downdrafts or decreased performance due to wind shear are encountered after liftoff, increase the pitch attitude as required, simultaneously ensuring the application of maximum thrust. Be prepared to allow airspeed to decrease into stick shaker speed range if necessary to sustain flight or avoid ground contact. Remember that V_2 speed is at least 20 percent above stall speed (1.2 V stall) and this buffer area above stall speed may be used to recover from a situation which demands maximum airplane performance.

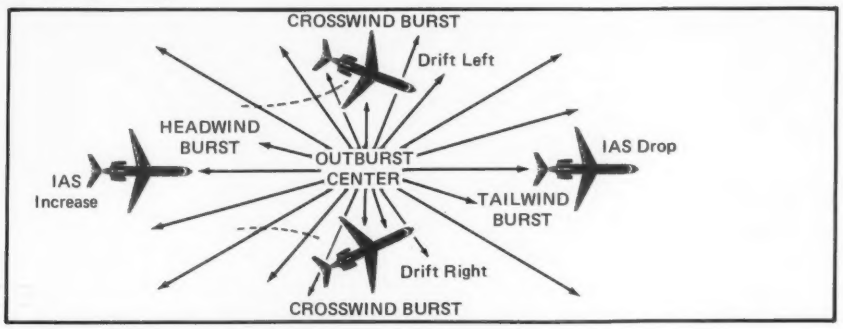
When wind shear conditions are observed or reported, appropriate additives of up to 20 knots should be made to the departure speed used following takeoff.

Another Point on Wind Shear: "Because unexpected changes in wind speed and direction can be hazardous to aircraft at low altitudes on approach to and departure from airports, it is essential that all such encounters be reported by the most expedient means to the tower . . . These reports will provide a means to immediately relay the wind shear condition to other arriving or departing aircraft, and/or consider alternate operations to other aircraft."

Such reports should be given in a clear, concise, and



Here is another example of the deadly potential of thunderstorm-generated low level wind shear. On the takeoff roll, the aircraft had a positive headwind component. As the aircraft was accelerating shortly after liftoff, the downburst and tailwind areas were penetrated. The winds then increased to a tailwind of 60 knots within 120 feet of ground level. Lift was insufficient to sustain flight.



Effects of downburst and outburst upon aircraft.

Of these, the most dangerous are the downburst, crosswind burst, and tailwind burst encountered near the ground. Outburst is defined as the strong outflow created when a downburst hits the ground and spreads out.

Fig. 3

understandable manner, not in positive or negative terminology. Examples of proper concise reporting might be:

"Abrupt loss of 20 knots encountered at 400 feet," or

"Gradual gain of 25 knots between 600 and 400 feet followed by loss of 40 knots between 400 feet and surface," or

"Abrupt wind shear at 300 feet, max thrust required."

Be aware that in wind shear conditions, it is possible to encounter both gains and losses in indicated airspeed during the same approach or departure. Under certain conditions, low level wind shear may be too severe to be successfully negotiated.

Another example of the deadly potential of thunderstorm-generated low level wind shear is shown in Fig. 3. On the takeoff roll, the aircraft had a positive headwind component. As the aircraft was accelerating shortly after liftoff, the downburst and tailwind areas were penetrated. The winds then increased to a tailwind of 60 knots within 120 feet of ground level. Lift was insufficient to sustain flight.

Reducing aircraft drag by selecting a reduced flap setting and increasing speed is highly beneficial. This significantly reduces the hazardous effects of low level wind shear on aircraft performance during these high-drag, slow-speed, low-altitude situations when the aircraft is most vulnerable. Be aware that landing with too much excess airspeed has some inherent problems on rollout, since kinetic energy increases as a function of the velocity squared (K. E. = $1/2\ MV^2$).

Figure 4 presents flight recorder data on an actual wind shear mishap that occurred during the execution of a missed approach. As the aircraft is decelerating for landing, a rapid rise in indicated airspeed occurs, only to be followed by an abrupt dropoff. The glidepath trace clearly shows the ballooning effect caused by the increased generation of lift as the headwind is encountered. (4A) After traversing the

FLIGHT RECORDER DATA

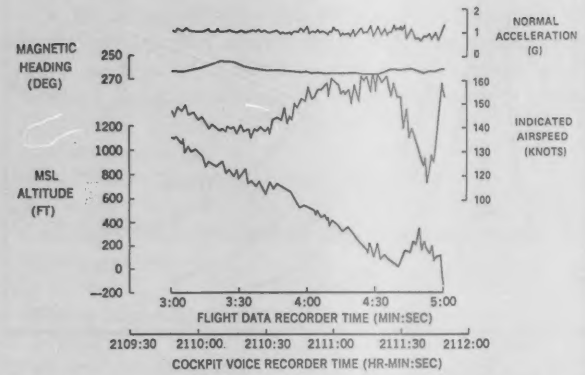


Fig. 4

DRAG

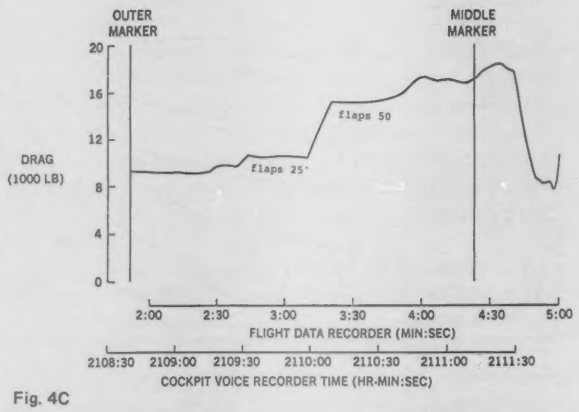


Fig. 4C

ANGLE OF ATTACK

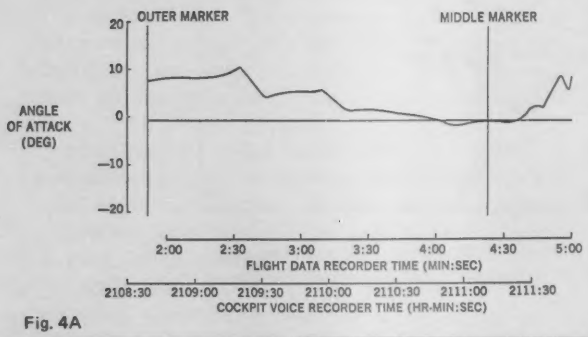


Fig. 4A

FLAP DEFLECTION
SLATS EXTENDED

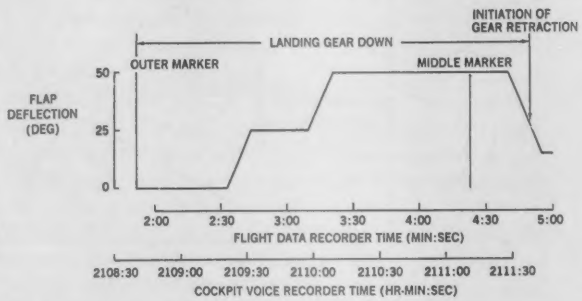


Fig. 4D

LIFT COEFFICIENT

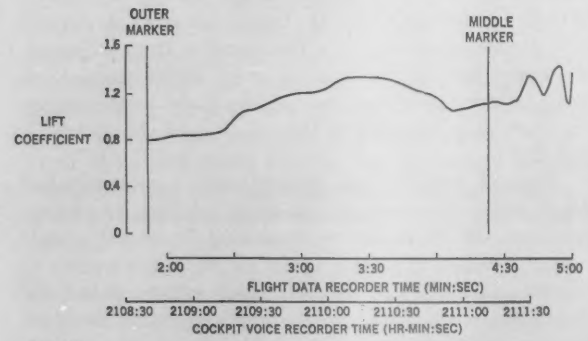


Fig. 4B

WIND PROFILE

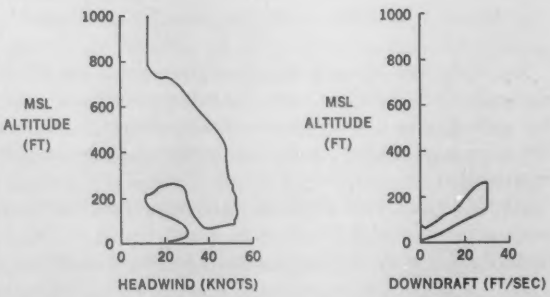


Fig. 4E

headwind, the resultant relative airstream causes the angle of attack to sharply decrease and even become negative for a time. (4B) Corresponding to this decrease in the angle of attack is a decrease in the lift coefficient. (4C&D) Note the significant drag rise when the aircraft is finally configured with gear extended and flaps set at 50 degrees. (4E) The headwind trace shows a rapid rise as the aircraft enters the outburst at approximately 800 feet AGL. This increase was temporary. It was then followed by an abrupt deterioration in headwind component at a very low altitude. Downdraft intensity reached approximately 1,800 fpm.

Regarding the stick and rudder shaker recovery technique, I feel that avoiding an *extremis* situation involving wind shear is obviously the best method of dealing with the problem. When avoidance isn't possible, I agree with American Airlines that consideration should be given to flying all the way down to stick and rudder shaker airspeeds if that's what you have to do to prevent a crash. The technique has a lot of merit. It may not be a recommended course of action at 1,500 feet (where you may have room to gain some airspeed by lowering your nose), but in lower level wind shear situations *when ground impact appears inevitable,* it seems the only prudent thing to do. It's certainly better than doing nothing and watching yourself crash! When you're forced to fly at speeds at or near stick and rudder shaker (approximately 1.1 V stall), good climb performance still exists. It is interesting to note that 1.1 V stall, while abnormally slow for transport and patrol aircraft, closely approximates the normal tactical aircraft's approach speed, so if a tactical Navy jet pilot experiences wind shear at low altitude on final, since he's already flying close to stick and rudder shaker speed, his best bet is to add maximum power (his strong suit) and execute a missed approach. (There's nothing like putting a little altitude between you and a problem!) When close to the terrain or water, accelerating the aircraft by lowering the nose to regain lost airspeed could result in a significant loss of altitude, a degradation in climb performance, and ground impact. Under such conditions:

- Add maximum power and execute a missed approach.
- For aircraft in which AOA is normally used on the approach: rotate to the (higher) AOA for best angle of climb until a positive rate of climb is established and you're clear of obstacles. Then accelerate to maximum rate of climb AOA as specified in NATOPS. If these AOAs are not published, wave off in accordance with NATOPS carrier-based procedures for your model.
- For other aircraft, rotate and maintain an *attitude* that results in stick and rudder shaker speed – or preferably – slightly above stick and rudder shaker speed.
- When a positive rate of climb is established, retract the landing gear.

Rotation to an AOA above optimum approach AOA is not generally used in carrier waveoffs due to the potential for inflight engagement of the arresting gear. Obviously, NATOPS waveoff procedures should be used if inflight engagement is a possibility (such as during an in-close waveoff from an intended arrested landing at an airfield).

Flaps should **not** be raised while at or near stick and rudder shaker or stall warning buffet. Raising flaps should be delayed until out of *extremis* and speed is increased to at least approach speed. The use of reduced landing flaps should be considered if encountering wind shear is likely.

Operators should practice the *extremis* recovery technique in both the aircraft (at the altitude used for practice stalls) and the simulator (at landing pattern altitude). The operator thereby develops a feel for the G and speed margins he has to work within and learns the characteristics of the aircraft and stall warning system (natural or artificial) at speeds between that used for approach, departure, and stall.

These operational techniques, which are recommendations to consider, are not addressed in NATOPS. They are not intended as absolutes. However, they represent some of the most current state-of-the-art procedures for dealing with wind shear. Furthermore, many of the recommendations have been taken from National Transportation Safety Board accident conclusions, commercial carriers' operating procedures, aircraft manufacturers' procedures, and F.A.A. Advisory Circular 00-5A. Although some of the techniques may not be completely accepted by the entire aviation community, I feel it is imperative to realize that many of the recommended procedures are significantly better than doing nothing.

Consideration should be given to this low-speed climb regime, since pilots have apparently been more concerned with loss of airspeed than flightpath control. This regime refers to those speeds less than V_2, V_{ref}, and approach speed but greater than V stall. This operating region represents an area of an aircraft's performance envelope that is not normally exercised. Although there is less margin for error, excellent climb performance is available. Therefore, when confronted with an *extremis* situation, two primary objectives should be to **remain above stall speed** and **generate distance immediately between the aircraft and the ground.** Maintaining an attitude that gives at or near stick and rudder shaker speed may exceed the maximum pitch attitude normally recommended during a missed approach or takeoff. If this slow-speed climb regime is exercised, however, it may provide the additional performance required to avoid ground impact. Airspeed can be traded down to shaker speed (kinetic energy for potential energy) if necessary to avoid ground impact. The classic aviation axiom that power plus attitude generates maximum performance is most appropriate for this scenario.

These comments can be generally applied to all types of fixed-wing aircraft, including the full Navy inventory. It is not the intent of this article to dictate how one should fly his particular type of aircraft. However, it is intended to stimulate thought among naval aviators and to propose some solutions to a phenomenon that is not yet fully understood. Low level wind shear represents a new frontier in modern aviation.

Understanding the basic fundamentals of low level wind shear is absolutely essential to all-weather flight safety. These thoughts will hopefully provide for the foundation and execution of timely, correct, and successful flight procedures.

Copyright Joseph F. Towers, 1982

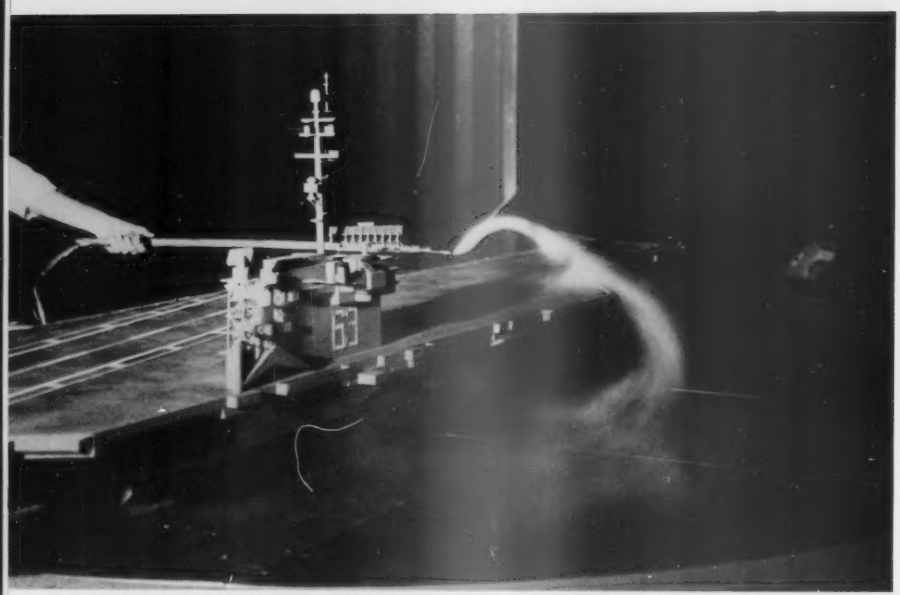
Look at these

AT NAEC Lakehurst, we're performing slope and wind tunnel tests in order to provide data on airflow around ships' superstructures. This includes identifying critical parameters and scaling effects to relate model tests to full-scale phenomena. The idea is to acquire data on a variety of ship classes to develop an understanding of the effective airflow phenomenon on flight operations. These tests can help us greatly in developing new hardware and procedures to improve aircraft performance and operational safety.

When an extremely turbulent environment in the airwake of a ship's superstructure mixes with an aircraft-generated flow field, degraded aircraft and operational safety can result.

In these photos, with wind over the bow simulating cruise relative winds, smoke and tufts are used to obtain visual observations of airflow patterns. This technique identifies selected airflows, assuring proper placement of instruments for velocity measurement.

Actual shipboard testing of aircraft is extremely time-consuming, requires substantial dedication of manpower and hardware, and is restricted to weather conditions available during the scheduled test period. For these reasons, full-scale research of ship-induced wind turbulence and methods of controlling it does not often occur.



After flow visualization work is complete, we record three-dimensional velocity measurements in the volume encompassing the flight platform and extending above and to the side of the platform. These studies are then used in conjunction with tunnel data to evolve comprehensive techniques of airflow display and analysis. Data can then be applied to hardware design and flight simulation.

CV-63

Watch that smoke curve! Right now, an exploratory effort for computer mapping of airflows for CV-63 class carriers is underway, where empirical and technical rationale are being applied to wind tunnel data.

We've been introducing smoke across the flight deck of this 1/100 scale model of the CV-63 in order to illustrate flow distortions over the deck and the formation of a large vortex along the lee of the ship. Significant flow characteristics have been recorded for the entire flight deck for both flow visualization and velocity measurement tests. (Photo courtesy of the University of Maryland)

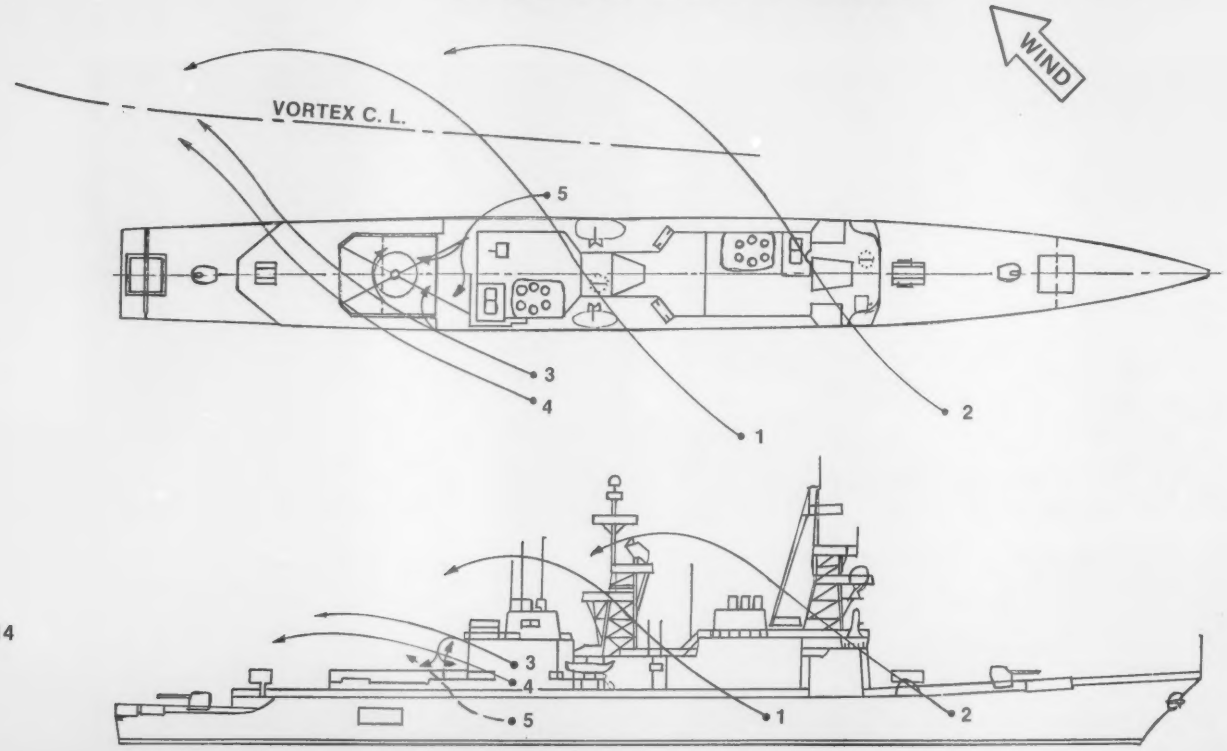
burbles!

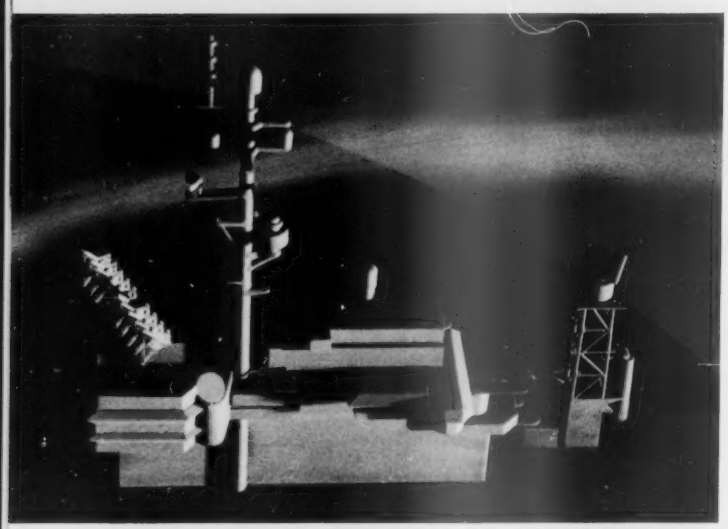
By Richard J. Perrelli
NAEC, Lakehurst, NJ
Principal Investigator
Ship-Induced Wind Turbulence Program

SPRUANCE-class destroyers

The complexity of airflow in the vicinity of the flight deck of a DD-963 requires the use of specialized flow visualization techniques to improve the visibility of the flow. A narrow plane of intense light is used to illuminate a cross-section of the flow being analyzed, thus allowing researchers to highlight only the flow of interest and ignore extraneous flows. Tests were conducted by NAEC personnel at Princeton University under contract with NAEC. (Photo courtesy of the NAEC Photo Lab)

Downsweep of air abaft the beam, DD-963 045° relative wind

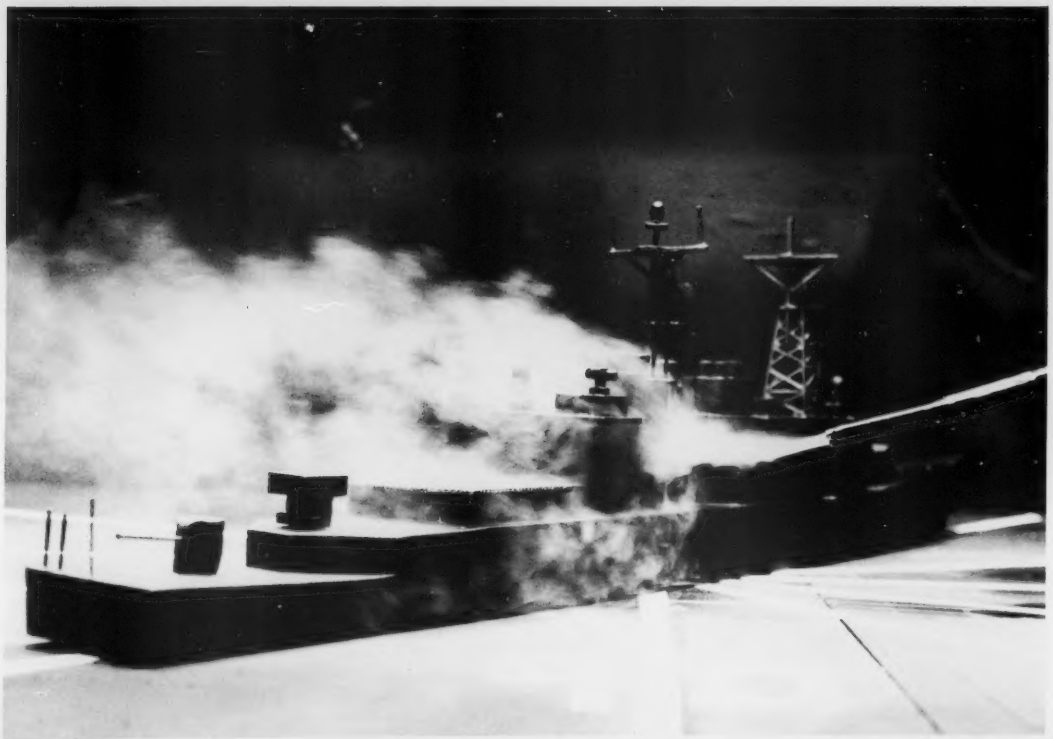




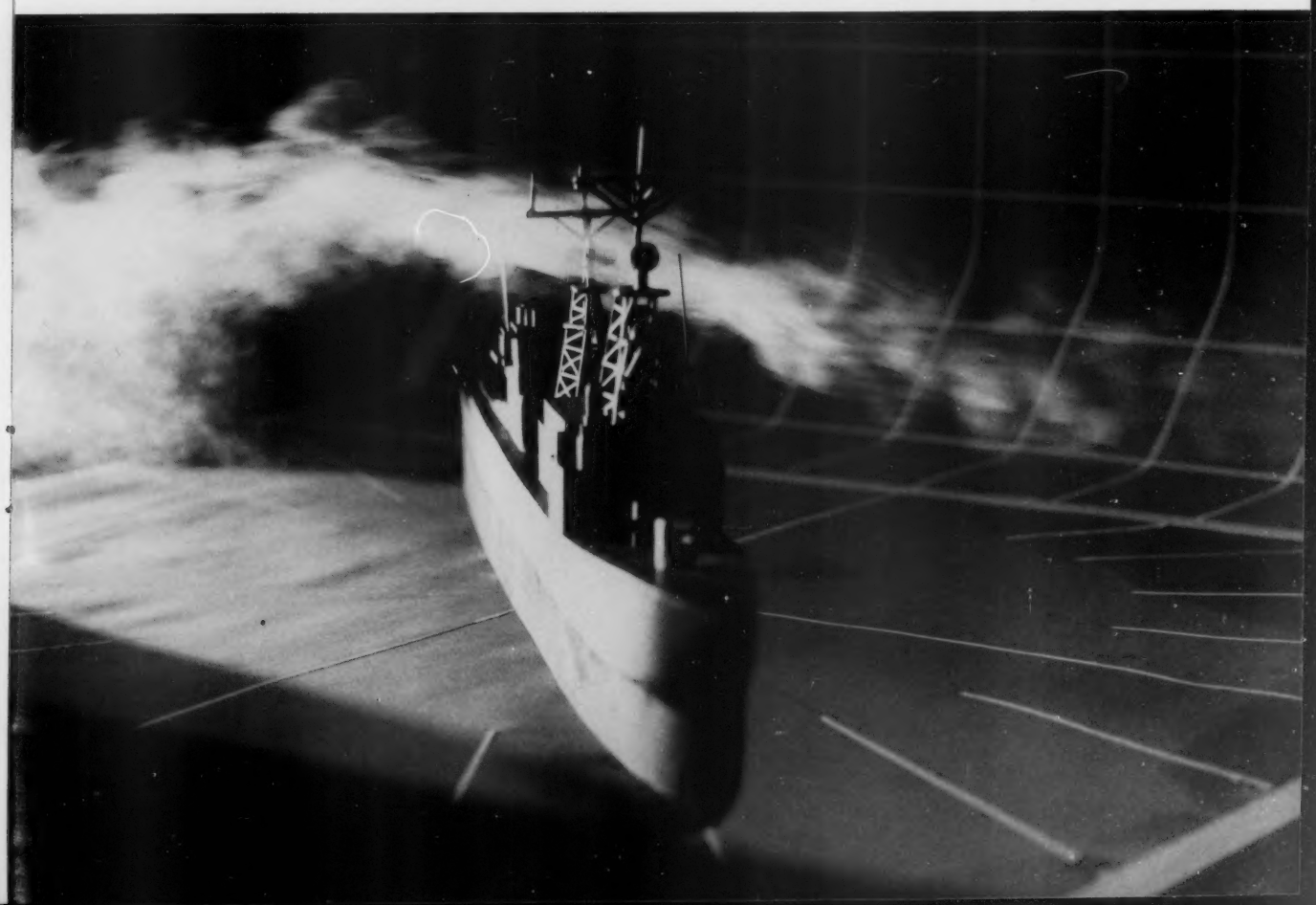
Note the way the smoke changes direction after hitting the island. Though these studies are preliminary, at least they're a step in the right direction and can ultimately help us in flight deck certification.

In the photo to the right, we introduced smoke above the superstructure of a 1/1200 scale model of the DD-963 to show the powerful vortex located in the lee of the ship. **The vortex is present for many relative wind conditions.** Flow visualization tests were conducted by NAEC personnel at Princeton University to identify flow characteristics in the masthead and over the flight deck prior to conducting velocity measurements. Wind tunnel velocity measurement tests were conducted at Boeing/Vertol Company under joint NAEC/NADC contract. (Photo courtesy of NAEC Photo Lab)

We plan to continue efforts to define shipboard wind fields in the future. One specific study will investigate differences between masthead wind and deck airflow patterns. The effects of gusts on moving flight wind fields will also be explored. Research and development funding to date has been provided by NAVAIR Code 340-A under 6.2-block funding. We're also currently developing a solid-state electronic wind measuring system to begin replacing in-service anemometers by FY-86. If you have any more specific questions, give me a ring on Autovon 624-7523, and I'll do my best to give you an update. ◄



By making wind visible, we can illustrate the extreme turbulence an aircraft can run into just above the flight deck.



Forever is a long w

By Russ Forbush
APPROACH Writer

THESE two flight incidents vividly illustrate how similar circumstances can result in the loss of one life and the saving of another. While there were many contributing factors preceding the flight in which an aircrewman was killed, it was the failure to follow a simple safety procedure that made the difference between life and death.

An H-46 lifted from its helo deck and headed for NAS Whitetower to pick up some cargo. Observers noted that the aircraft's cabin door looked closed as the *Sea Knight* departed. Approaching Whitetower, the pilots made a descending left turn from 1,000 feet to line up with the duty runway. The maneuver was in progress at 110 KIAS in a 10- to 12-degree left bank at 500 feet when everyone heard a loud bang. The HAC, flying from the left seat, turned his head aft and saw the cabin door fully open and the long cord trailing out.

A moment earlier, the NAS tower had radioed that something had fallen from the H-46. Seconds later, the pilot landed his aircraft on the runway and notified the tower that his crew chief had disappeared.

The body of the crew chief was located about 20 feet from the approach end of the runway. All required flight equipment was on his body and worn properly, except the SPH-3B flight helmet, which was found a short distance away. His gunner's belt was correctly adjusted and positioned around his chest. It was functional and undamaged.

What had happened?

One Life Lost. Two days earlier, the crew chief had been required to remain aboard ship as a member of the night security watch. His was a nonsleeping post. At 0700 the following morning, he was relieved from duty and immediately hit the sack. Rising at noon, he then requested and received special liberty until 0700 the next morning.

Eager to see the sights, he changed into civilian clothes, headed for town and, upon arrival, had some lunch. Day turned slowly into night while he visited several bars and hoisted a number of beers with friends. He was seen at one of the bars by his immediate supervisor, who talked with him and later revealed that while he was drinking, he didn't appear intoxicated.

He emptied his last glass between 0230 and 0400 and then headed back to the ship, arriving at 0430. Waking at 0730, he roused his first mech, and they had breakfast together. The two then headed for their aircraft and commenced a daily inspection in preparation for a 1320 launch.

During preflight, both aircrewmen confided to each other that they were under the weather. Following the inspection, the crew chief was able to catch a few winks before the pilots arrived to begin preflighting their *Sea Knight*. During the preceding 54 hours, he'd managed no more than 11 hours of sleep. His supervisor knew about this and about the crew chief's drinking until the blue hours of the morning. Still, he'd scheduled him for the upcoming flight because he felt that the crew chief was "mentally alert" and "not tired."

The pilots finished preflight, started up, spun the rotors, and began some touch-and-go landings onboard ship. At the time of launch, the crew chief was observed occupying the first troop seat on the right side of the helo. His seatbelt was fastened. He was also wearing a gunner's belt that appeared to be hooked to a 5,000-pound cargo tiedown under the rescue winch.

After observing several touch-and-goes, the helo tower diverted the H-46 to the logistic transport mission at NAS Whitetower. Prior to conducting this mission, the HAC made three unsuccessful attempts on ICS to query his crew chief about the status of his cargo hook. The HAC then turned and yelled into the cabin to alert the crew chief, who responded by raising his head and hands and answering over the ICS. The HAC interpreted the hand motions as the crew chief reconnecting his ICS long cord to his helmet. No one would ever hear from the crew chief again.

Shortly after the H-46 taxied to the NAS line, an investigation was made of the cabin door. It operated normally in the opened, closed, latched, and unlatched positions using both the inside and outside handles. Except for the aft cable support assembly, the door was undamaged. It's possible that damage to the support assembly resulted from the excess load placed on it when the cabin door inexplicably opened in flight.

Investigation of the cabin area revealed that a second gunner's belt was hanging from the rescue hoist and was hooked to a 5,000-pound tiedown.

Throughout the mission, the crew chief appeared to be in good spirits. Approximately 10 minutes before the fall, he spoke with the HAC when he brought him a pocket checklist that had dropped to the deck.

Since there were no witnesses to this mishap, only assumptions can be made as to what transpired in the cabin prior to

vay to fall

its occurrence. There were, however, several possible factors that may have led to this mishap, and they are discussed below:

- First, the crew chief did not allow enough time to transpire between his last drink and acceptance of flight duties. For this, he was in violation of OPNAVINST 3710.7K. He was also in violation of a squadron policy memo by not allowing himself proper crew rest prior to the flight.
- The crew chief's immediate supervisor was remiss in scheduling him for this flight when he was well aware of his lack of sleep and alcohol consumption only a few hours before the flight.
- It will never be determined how or why the cabin door came open in flight. The fact is, however, that the crew chief was visibly tired and had admitted to a hangover. Under these conditions, a judgment error could very easily have occurred. In this instance, it's probable that the crew chief was unaware that his gunner's belt wasn't fastened to the aircraft.

Drinking alcohol and losing sleep during the hours immediately preceding a flight have done more than one aircrewman in. Fliers who find themselves in this condition should make it known to their supervisor. Additionally, supervisors must ensure that no aircrewman mans a flight seat until he is physically able to do so. Had this been the case here, a tragic loss of life would have been spared.

One Life Saved. Following a passenger drop at a helipad, an H-46 *Sea Knight* was getting ready to lift and reposition for a hot drink at a refueling pad. The crew chief donned his gunner's belt and closed the cabin door. He stowed the outside handle and then bumped the door to check it for security. The aircraft lifted and transitioned to forward flight. At approximately 50 feet AGL and 50 KIAS, in a left turn, the pilots heard a loud thump. Looking aft, they found that the cabin door had sprung open and the crew chief had fallen from the aircraft.

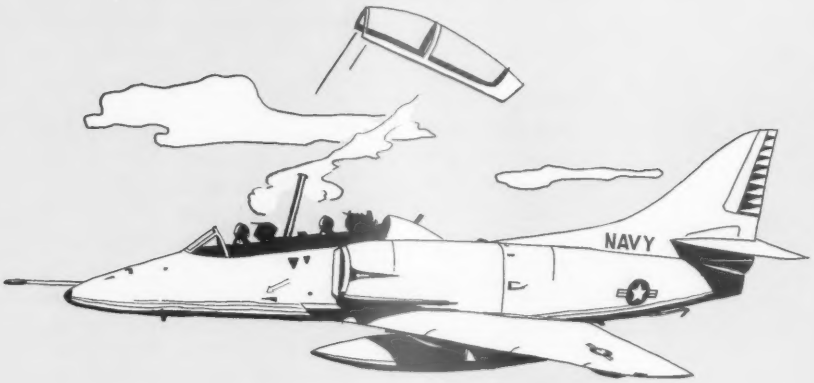
The crew chief was still on ICS and informed them he was secured by the gunner's belt and was able to reenter the cabin without assistance. The aircraft proceeded to the refueling pad and landed.

In falling from the aircraft, the crew chief's only injury was a broken finger. There was no damage to the airframe.

An investigation of the cabin door revealed no malfunctions. The door had not been secured properly prior to liftoff, and airframe vibrations had caused the latching lugs to release. Proper use of the gunner's belt in this flight saved the crew chief's life. He made the correct decision to don his belt after assisting the passengers in leaving the H-46 prior to liftoff.

These two incidents occurred because a cabin door opened during flight. Units with this hazard potential should take warning and ensure that their aircrewmen are fully aware of the proper method for securing these doors.

We're all susceptible to gravity, so remember this: one of these crew chiefs donned his gunner's belt and ensured it was secured. It saved his life. Have you been wearing yours lately?



A ride in the wind blast. Inside a TA-4 flying straight and level at 150 KIAS and 15,000 feet MSL, two pilots were performing a postmaintenance functional checkflight (PMFC).

The PMFC progressed smoothly until it became time to deploy the emergency generator (RAT). When the emergency generator "T" handle was pulled, the emergency generator deployed and, lo and behold, along with it went the canopy. The TA-4 fliers then descended in the wind blast to a nearby military airfield, where a successful precautionary landing was made.

Upon exiting the TA-4, the pilot at the controls (PAC) noticed that the IFF panel was projecting upward about 3 inches from its normally flush position. A postflight inspection revealed yellow paint markings on the IFF control panel function knob. Further investigation revealed that with the IFF control panel elevated 3 inches from its normal position, the function knob would fit perfectly into the circular-shaped emergency canopy jettison handle. The consensus is that when the PAC deployed the RAT, his arm moved the dislodged IFF control panel aft, allowing the function knob to nudge the emergency canopy jettison handle, with subsequent loss of the canopy.

This is a prime (although unusual) example of Murphy's Law that could easily have been avoided. Had the PAC conducted a thorough preflight, perhaps a canopy would not be missing right now. Once again an incident occurs that stresses attention to detail to all aviators, especially during a PMFC. In this case, maintenance personnel were also remiss by not ensuring that every component installed in the TA-4 was thoroughly secured.

Wheel Off, Heads Up. "Navy Delta 977, it appears your starboard wheel has fallen off, over." That understated transmission turned what was scheduled to be an uneventful student syllabus flight into anything but. AC3 Rick Ketchum and AC2 James Paulk were on duty in the NAS Corpus Christi control tower when VT-31's LCDR Jack Boniface and ENS Don Stogner launched in their T-44. As the aircraft took off, both controllers noted a wheel assembly rolling down the runway and correctly assumed it had fallen from LCDR Boniface's aircraft.

Since the tower's transmission had been made after the gear was raised, LCDR Boniface elected to leave the gear in that position. After consulting with the squadron duty office, LCDR Boniface flew out over the Gulf of Mexico, where he was joined by another squadron T-44. All doubt as to the status of the aircraft's starboard gear was erased when the wheel was visually confirmed missing. Consultation with squadron and *Beechcraft* maintenance representatives determined a gear-up landing would be the safest alternative.

For the next 2 hours, LCDR Boniface continued to orbit off the coast, preparing for the first gear-up landing of a Navy T-44A. This enabled him to review NATOPS procedures and burn down fuel to minimize the possibility of fire on landing.

LCDR Boniface, in winds gusting up to 25 knots, made a picture-perfect approach and landing. His landing was so well executed that observers were moved to break into spontaneous applause. The NAS Corpus Christi crash crew was on hand, laying down a protective blanket of foam within moments of the aircraft coming to rest. There was no fire, however. In fact, there was only minimal damage to the aircraft. Replacement of both engines and propellers and minor repair to the nacelles and fuselage were all that was required to return the aircraft to a flying status.

The happy and successful conclusion to this potential diaster was a direct result of alertness, teamwork, and the professional airmanship of LCDR Boniface. Attaboy!

A Check in Time. An HH-46A from HC-11 departed NAS Pt. Mugu on an IFR clearance to NAS North Island.

AIR BREAKS

About 3 to 5 minutes later, the crew chief reported that fuel was discharging from the starboard side of the aircraft. The pilot cancelled his IFR clearance and headed the H-46 back to NAS Pt. Mugu. En route, the fuel discharge was traced to the No. 2 engine compartment gravity vent/drain. The helo landed uneventfully and was shut down without the APP.

Following shutdown, the No. 2 engine compartment door was opened and a significant quantity of fuel drained onto the ramp. The spill was wiped up and then several lines and fittings were checked as potential leak sources. With the firetruck and crew standing by, the No. 2 engine was motored (fuel boost on/ignition off) to assist in troubleshooting the leak. As the engine reached about 20 percent N_g, a massive amount of fuel gushed from the fuel control. The engine condition lever was retarded to STOP and the APP was secured.

The bad fuel control was removed and tested by depot level maintenance personnel and found to be RFI. In addition to the normal flow bench inspection, however, the flow bench operator added a step — he ran the fuel control with a plug installed in place of a flow bench fitting. Normally the plug is reinstalled if the fuel control checks RFI and no further testing is performed. The operator added this step because he noticed that the O-ring appeared swollen and deformed when he removed the plug for the initial flow bench run. The O-ring was pressure tested and a leak was detected near the area identified by the flightcrew. A new O-ring was installed and a pressure check revealed no leakage.

Although JP fuel is formulated to have a very high flashpoint, liquid fuel being pumped into an engine compartment while the engine is running could lead to a catastrophic engine compartment fire and/or explosion. This would put the aircraft in a single-engine situation and severely damage other engine and drive system components.

This hazard report highlights the importance of so-called "routine" procedures. A heads-up crew chief detected a potentially catastrophic hazard on a routine aft station check. Too often, routine checks are bypassed and mishaps result. A word to all naval aviation — **if a check is required, make it!** Your life and the life of others could hang in the balance.

Flabbergasting Forecasting. A recent hazard report highlighted a weather forecasting problem guaranteed to expedite the growth of gray hair.

A couple of A-4 drivers filed an IFR flight plan from their east coast air station to a midwest military airfield. Scheduled takeoff time was 2030Z. Forecast weather at destination was 8,000 feet scattered, variable broken, 25,000 feet broken, and 7 miles visibility with no snow forecast for 24 hours. A 1-hour delay was encountered, and at 2045, the pilots received a no-change weather update with a void time of 2200Z.

The *Skyhawks* departed at 2130Z with weather forecast as 7 miles visibility and no obstructions at FL280. En route, they climbed twice — first to 31,000 feet to stay in the clear and later to 35,000 feet. In spite of this, they remained in IMC.

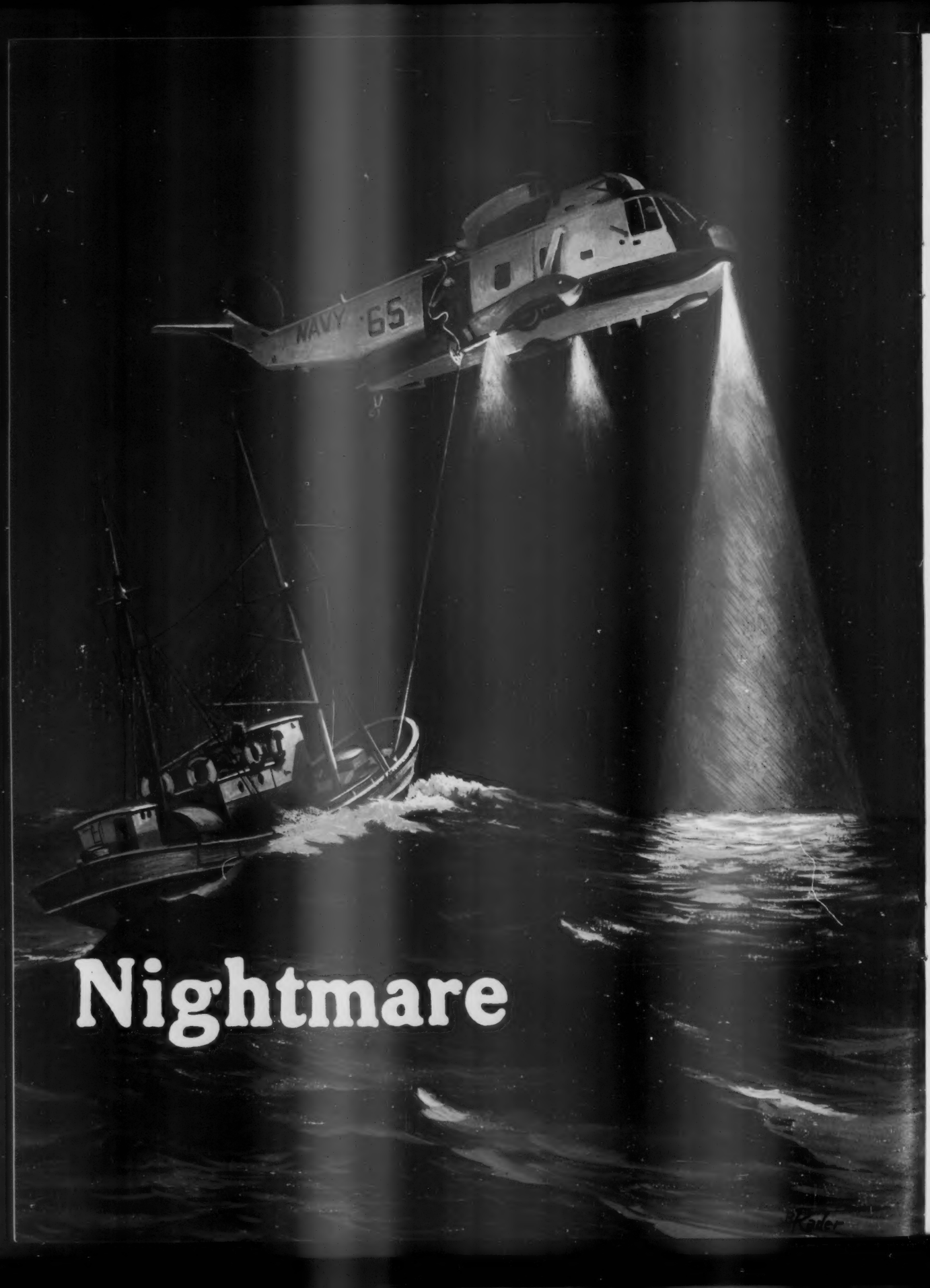
When they were 100 nm from their destination, the pilots called ahead for a local weather forecast. The response was 1,400 feet broken, 2 miles visibility. At 2330, the *Skyhawks* landed with a 200-foot ceiling and ½-mile visibility in snow showers.

What happened here? The pilots received a standard weather briefing on DD Form 175-1 prior to departure from home base. En route, they checked the weather, and about 20 minutes before landing, they checked it again. None of the three weather briefings indicated the existence of snow showers or icing at the destination. The severe icing encountered in this situation could easily have resulted in a condition where power required would have exceeded power available.

In general, advance notification of weather conditions is essential to flight safety. Forecasts that have little resemblance to the actual weather encountered are not in keeping with the standards necessary for the safe operation of naval aircraft. Why destination weather personnel were unaware of the miserable weather is unknown. But it hardly seems possible that the forecast was based on current meteorological conditions and available data.

The squadron CO had the following to say regarding this hazard report: "The professionalism of these two aviators is apparent by the number of times they attempted to obtain accurate weather information. The constant monitoring and reporting of rapidly deteriorating weather conditions by ground facilities is critical to flight safety. This would seem to be a self-evident, universal truth. In this case, however, two single-seat, single-engine aircraft were somehow placed in a position of jeopardy. This incident should serve as a vivid reminder of the need for unswerving professionalism and vigilance by all facets of the meteorology system."

It should also serve as a reminder to all aviators that, when airborne, one can't rely solely on those on the ground to provide the most accurate information. Bad weather is like a near-miss — see and avoid whenever possible. ◄



Nightmare

By LCDR Pete Blackwood
Staff Safety Officer
COMSEABASEDASWWINGSLANT

"The hoist is pulling us out of the sky!"

HELICOPTER search and rescue is defined by some as the only evolution in naval aviation in which we are willing to risk four invaluable crewmen and an extremely expensive aircraft to save a single life. As a professional helicopter pilot, I believe that judicious preparation for a search and rescue mission can alleviate all but the most unpredictable of hazards. However, as a wise man once said, "The best laid plans of mice and men . . ."

1915: Last day of a 3-week at-sea period. Flight ops are over. Preparations are underway for a port visit the next day. Winding down . . .

1930: Notification is received of a fishing vessel sinking 80 nm away.

1945: Experienced SH-3H helo crew is selected and assembled with CV engineers in readyroom. Plan is to lower a P-250 pump and its accessories to the distressed vessel. CV engineer will be lowered if HAC determines such an action is safely feasible.

2000: Weather is CAVU with a full moon, seas 3 to 5 feet with a short-interval swell, and 20 knots of surface wind – almost ideal for a night transfer.

2055: Rescue and escort helos are airborne. Briefing was thorough – crew continues to discuss general conditions and available options while en route. Overhead E-2C is providing comm link from SAR scene. Stricken vessel has an HF, so helos, CV, E-2C, distant Coast Guard rescue center, and stricken vessel are all able to talk. How could things be better?

2200: Helos are on scene and assessing situation. Second fishing vessel is standing off, ready to assist. Stricken vessel is still high in the water, the ship's captain is calm on the radio. Boat is broadside to the 5-foot swells and DIW. Antennas and fishing outriggers are everywhere. This isn't going to be easy.

2215: Several low passes have been made, and our helo is now hovering at 60 feet alongside distressed vessel. Bow is the only feasible transfer point. Tending line will be used as a tether on our hoist. We instruct vessel's crew not to fasten hoist hook or tether to anything! Decide it's too dangerous to attempt transfer of CV engineer. Place second fishing vessel off helo's nose to aid in providing visual horizon. Arm cockpit hoist guillotine circuit and brief crew chief to call for hoist guillotine if necessary. Illuminate guillotine switch with map light, just in case. Altitude coupler engaged, cyclic coupler off. "Easy right, easy forward, pump going down . . ."

2245: Sea state makes holding helo over stricken vessel nearly impossible. Back off . . . cyclic coupler and hover trim engaged. This time, pump goes down quickly and is on deck. Hey, that was easy! "MAD TRAIL" capsule illuminates. "What's going on back there?" Violent pitch of vessel causes hoist cable to cut into MAD skirt and become lodged there. Suddenly, helo nose pitchup of 5 degrees and left yaw of 25 degrees occur simultaneously! Pump is lodged against vessel's deck edge combing and a big wave has opened the gap between the helo and the vessel. The hoist is pulling us out of the sky! "Guillotine, guillotine!" BANG!

2300: Steady hover. Pulse gradually residing. Everything is okay. Transition to forward flight. Orbit overhead and explain our situation to everyone. Ask the vessel if he can possibly stay afloat until morning. "Yes, sir, no problem!"

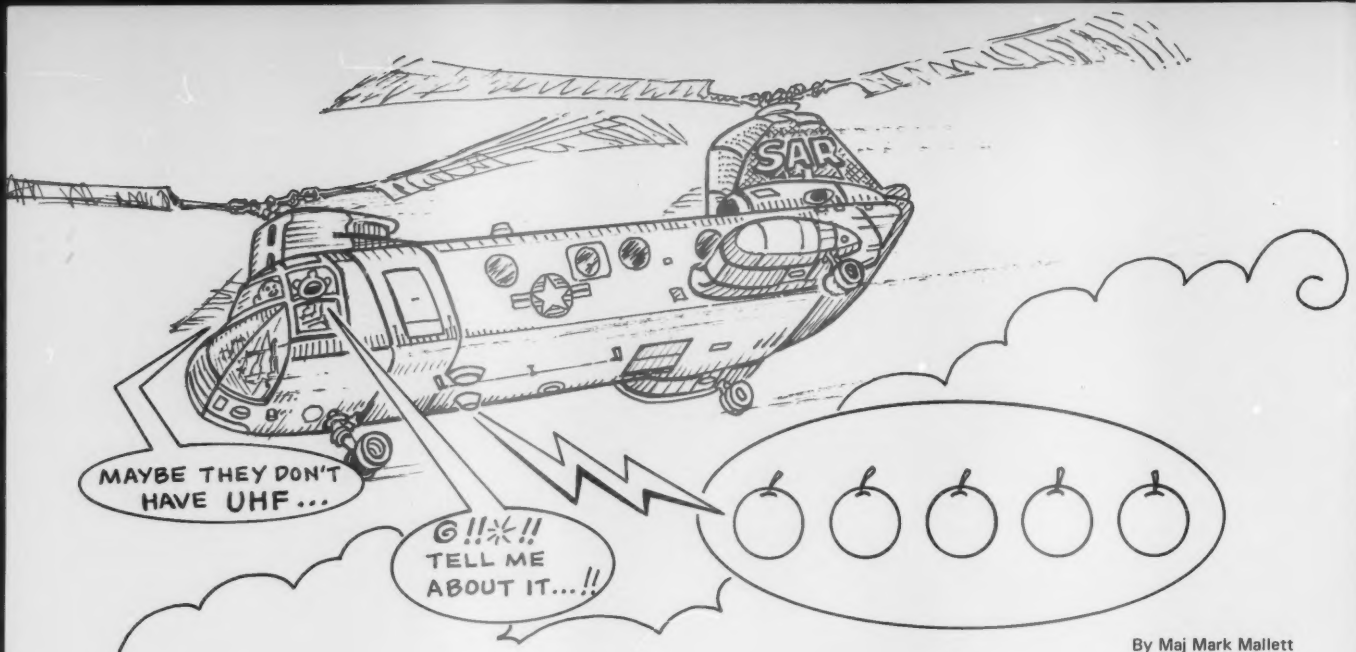
Silence.

(Why are we here?)

Later that night, a very careful readyroom analysis of this incident provides some food for thought. No one ever thought to ask the distressed vessel if he could stay afloat until first light. After all, he was sinking! Our ship had a long overnight transit to its port call and did not wish to remain in the area longer than necessary. Communications were progressively degraded as the distress call went from the "sinking" vessel to the Coast Guard, then to the CV, and then to the helo crew. In our haste to be heroes, we attempted an extremely hazardous hoisting evolution that was unnecessary under the circumstances.

Well, we're older and wiser, and this near-mishap is only a nightmare to us now. However, here's a suggestion for SAR types for future reference. None of us in that four-man crew had ever considered arming the hoist guillotine circuit in our collective 38 years of experience. Why it occurred to us to do so that night is a mystery. However, next time you're out night flying, see how fast you can find the jettison selector, select "hoist" to arm the circuit, and place your finger over the "activate" button – all while in a dark cockpit in a coupled hover. But for that one precaution, there might be a decidedly different ending to this story. As I said in the beginning, "Judicious preparation for a search and rescue mission can alleviate all but the most unpredictable of hazards . . ."

After reading this story in rough form, the Safety Center's H-3 analyst contacted LCDR Blackwood. Together they agreed that a NATOPS change recommendation will be submitted to the NATOPS model manager to include advice on arming the hoist guillotine circuit in night situations like these. –Ed. ◄



By Maj Mark Mallett
HMM-365

DUET WITH A HANGMAN

TODAY an aviator died, and as a rescue team, we were pretty much a flop. Sure, we could aviate, because our ready MedEvac crew and CH-46 were on 30-minute alert. And we could medicate, thanks to the flight surgeon and corpsman we had aboard. We could navigate, since the crash was at a forest fire that could be seen for miles. But we couldn't communicate with the fire bombers who were directing us to the crash site, hidden under oceans of smoke, because the fire bombers were all VHF-equipped and our CH-46 was UHF-equipped.

After 40 minutes of circling and dodging, a second CH-46 arrived on the scene, went high, and talked to Wilmington Approach Control on UHF. They in turn talked on VHF to the fire bombers, who then directed us to the crashed aircraft, a fire-spotting T-34B.

Our consciences were somewhat salved with the knowledge that the Forest Service pilot was killed on impact and our lack of communications wasn't a factor in his death.

Someone once asked a hangman if he woke up screaming, and he replied, "Doesn't everybody?" When a life is at stake and the rescue is hampered because the pilots can't communicate between aircraft, our consciences become pretty vulnerable and we wake up screaming, just like the hangman.

Marine helicopters are radioed exclusively for their mission and tasks. We're expected to communicate with ships, Marines, and faraway places. To do this, we have UHF, FM (normally called Fox Mike), and HF. The rub comes when a Marine helicopter gets tasked for some event which is not a part of its specific mission but is well within its capabilities. The following sea stories about such events have been compiled by a panel of experts at the MCAS(H) New River O'Club bar:

Event. A CH-46 joined in a CONUS overwater SAR effort with three Coast Guard helos and a C-130. The CG helos were VHF only, the CH-46 was UHF only. The C-130 relayed transmissions within the flight.

Event. A CH-46 and a UH-1N were scheduled as a flight from NAS Sigonella to NAF Napoli. Due to the lower flight regime of helos, and the location of Mt. Etna and Mt. Vesuvius, UHF communications ended about 20 nm from each base. (Note that en route VOR stations were used as navigation aids, because they were white and easy to see from the air . . . Our helos are TACAN only, too, but that's another story.)

Event. An H-34 had a paradrop mission at the airshow at Oshkosh. This airshow was big, with everything from warbirds to home-built flutterbys in the air. The FAA did a fantastic job of segregating traffic by type and airspeed, with special attention given the radioless puddle jumpers. The H-34 entered the pattern with the other non-VHF/no-radio aircraft, among them a *Breeze-E*, a *Ryan PT*, a *Stearman*, and something some guy must have built in his bedroom!

Event. A CH-46 north of D.C. had a land-ASAP emergency. Montgomery County airport was below minimums and Andrews was 26 miles away. The pilots opted for Montgomery County, hoping that Washington Approach Control would be able to warn the heavy local traffic (all VHF-equipped) of a great, green, wounded helo charging into their midst.

Event. After Hurricane Frederick, three Marine helos were sent to Guadeloupe to fly disaster relief. Their base was Pointe-a-Pitre International Airport, which had only VHF. The helos had to operate NORDO off an airport with lots of traffic that occasionally included big hummers like 747s and C-141s.

Event. A mixed bag of CH-46s and CH-53s hauled some Marines from NAF Napoli to the Persano training area. Their flightpath was over an Italian military airfield which was briefed as being closed. When the flight returned to base, the leader almost got a flight violation for not calling the Italian tower on 123.0.

I believe that the guys in higher headquarters really do read our after-action reports. They listen to our wailing and gnashing of teeth about our lack of VHF radios. There's a report from a SAR conference in 1980 that mentions a VHF-capable radio called the ARC-182. According to the SAR folks, this radio is anticipated to be installed in naval aircraft in the future. But the word "anticipate" is like the diplomat's statement of "I'll give you an indefinite provisional maybe, but don't hold me to it." Delivering isn't all that simple, because the guys around the Beltway have other problems to worry about (POMs, MILSPECs, contracts, mission statements, and J-Staff coordination) that you and I in the cockpit don't even dream about.

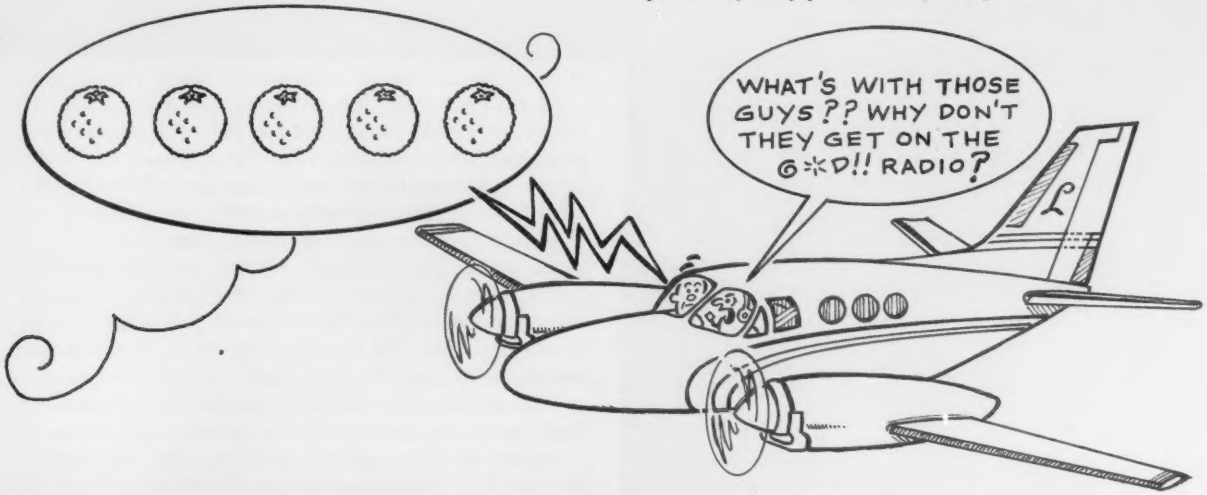
But dream we can. Dream about the ARC-182, the ARC-115, the ARC-114, and all those other neat radios by *Narco, Collins, King,* and *Bendix* that are advertised in *Aviation Week and Space Technology*. Someday our dreams may come true, but until then, we must face reality and plan accordingly:

- When in foreign skies, anticipate not having positive control available. Except for major airports, it's all VHF out there. Positive control means you've got to talk to somebody, and without VHF, you can't. File IFR whenever possible. If you must fly VFR, try to talk to the ship (if feasible) on HF, even if it's only to provide position reports.
- When operating with VHF aircraft on the same mission, do anything to talk to them. Try approach control. If it's really important, consider trying Guard. There might be somebody around who can provide a radio relay.
- When destined for a VHF-only airfield, call ahead by land line or relay through approach control or FSS. When outside CONUS, have the U. S. Consulate pass the word.
- When conducting multiple operations out of a VHF-only airfield, put somebody in the tower with either a PRC-77 or PRC-75 to transmit instructions.
- When entering a VHF-only airport, fly the local pattern. Make like a *Cessna* 150 and enter 45 degrees to the downwind at 1,000 feet AGL, fly a positive base leg, and use a long final. Look in the AIM to see how the civilians do it.

Helicopter aviators, it's going to happen to you. You'll be radio WOXOF in skies that are CAVU with VHF communications. You'll be able to talk, but nobody will hear. It's a heads-up ballgame. You have to fly as safely and gentlemanly as possible and keep your eyes out of the cockpit and your finger on the ONC. Keep alive that one faculty that can't be engraved in stone or described quantitatively in the books – headwork.

Do all this, add a little luck, and I'll give you an indefinite provisional maybe (but don't hold me to it) that you'll dream sweet dreams instead of joining in a duet with the hangman.

The lack of VHF communication is a well-known problem, and yes, someone up there does care and is doing something about it. Mr. Fred Hall, VHF Project Engineer (NAVAIRSYSCOM Code 53341G), says two programs are currently in the mill. The first is ARC-182 (UHF/VHF AM/FM radio), which is still undergoing systems analysis and isn't expected to become available before late 1984. It's planned for inclusion in most seagoing aircraft. The second is of primary interest to the SAR helo community. This program is in response to CNO direction calling for off-the-shelf purchases of VHF communications equipment (i.e., ARC-186; Collins VHF 20B). Through this program, VHF radios for SAR helos may become available by FY-83, but everything depends upon "indefinitely provisional" funding. – Ed. ◄



A shepherd g

IT WAS cool and dark as the A-7E climbed above the carrier for a night tanker mission. It looked as if nothing could ever happen on a night like this, so the pilot naturally felt as if something were going to happen. Moments later, CATCC transformed dream into reality by informing our *Corsair* pilot that they had other plans for him.

He was to lead a NORDO A-7 in for a night carrier recovery. Joining the mute *Corsair*, he shepherded it on two approaches to the CV. The first resulted in a waveoff due to a poor profile. The second turned out to be a hook-skip bolter.

Next decision? To scrub the NORDO bird's carrier landing. Both planes were diverted to land at a nearby naval air station.

Shortly after the carrier dropped from sight behind them, the two A-7s found themselves in a straight-in approach for

gets fleeced

By Harry "Bud" Baer, COMOPTEVFOR, Norfolk, Virginia

landing at the base. About a mile from the runway, while the NORDO aircraft continued in for his uneventful landing, the mishap pilot waved off, raised his gear, and accelerated to flap retraction speed. He then changed his mind and requested a turn downwind. He was cleared and turned right to a wide downwind with flaps down but landing gear still up. (Can you guess what's going to happen?)

Normal habit patterns call for dropping both gear and flaps when entering the landing pattern; also, leaving both gear and flaps down while in the landing pattern. When the pilot started to clean up, then changed his mind and turned downwind, his normal procedure would have been to leave both gear and flaps down. He glanced at the gear indicators once in the approach, but the fact that they were up just didn't register. (You do know what's going to happen, don't you?)

During his turn to downwind, he concentrated to avoid overflying base housing and a hospital (also on gaining altitude overwater to dump down to landing weight). At the abeam position, his thoughts were on spotting the runway lights, which were partially masked by high terrain. Focusing on these external factors may have distracted him from a very basic landing procedure – lowering the gear (you guessed it). Shortly before touchdown, he advised the tower, "Bluefox 173 down and locked for a full stop."

As you earlier surmised, our guy did belly in. Ruined an almost perfect day. A couple of feet off the ground, he suddenly awoke to the fact his gear wasn't down. The runway was moving up closer than it should have. He had a sinking feeling. But it was too late for waveoff. His A-7E tobogganed the runway. He wisely shut down the engine and attempted to maintain lateral control while scraping down the runway. The plane skidded some 400 feet, coming to rest about 3 degrees right of the runway heading and about 6 feet right of the centerline. Fair piloting under stressful circumstances, yet inappropriate for winning any medals.

At this point, having truly attained the dubious status of "mishap pilot," he quickly unstrapped, opened the canopy, and scrambled over the port side. A crash crew immediately extinguished a small fire in the lower engine bay. Shortly afterward, the plane was hoisted by crane. Its gear was lowered using an emergency gear extension system, and it was towed to a hangar. Naturally the craft had extensive underside damage.

Sure, it could have been worse. It certainly wasn't the first time a Navy pilot had inadvertently bellied in and, regrettably, it won't be the last. But this flier, with nearly 3,000 flight-hours under his belt (more than 1,800 in the A-7E), could merely scratch his head and wonder why.

To try to determine the reason, an informal survey of wheels-up and near wheels-up landings was conducted using computer runs and interviews with air wing pilots. Mishap-causing elements appearing most often included:

- Fixation.
- Distraction.
- Raising landing gear and leaving flaps lowered in the landing pattern.
- Strong predisposition to read "wheels down" from gear indicators actually showing them "up."
- Turning out the flashing wheels warning light due to flying in the pattern with wheels up, flaps down.
- Interrupted normal habit pattern.

In this case, three contributing pilot factors were relaxation, distraction, and interrupted habit pattern. The pilot relaxed vigilance and attention after his NORDO wingman landed. He said he experienced relief at touchdown, something like "the toughest part of the job was over." Little did he know. Also, he was distracted by the previously mentioned conditions – the base housing and hospital below, the partially hidden landing runway lights, and dumping fuel.

The third factor, interrupted habit pattern, was the most important. He had just completed two trips around the carrier with gear and flaps down. After dropping his NORDO playmate off at the base, he intended to depart the pattern in order to reenter for his own visual straight-in approach. He raised his gear while accelerating to flap speed, then changed his mind and turned downwind. When he relaxed his vigilance after completing a period of tense flying, the strength of his normal habit led him to believe the gear was down. The "up" indication on his landing gear indicators simply did not register with him. It's no secret that habit patterns can encourage the mind to "expect" certain perceptions (i.e., turning downwind implies the gear is already down) when they aren't really there.

Another consideration was the wheels/flap warning light. After the mishap, the A-7E system was tested by simulating various wheel and flap positions through actuation of position indicator switches. The system worked with gear down and flaps down but did not function properly with flaps down and gear up because of a relay failure. Recommendations to correct this material deficiency resulted.

Finally, it would be nice if tower operators could warn fliers when no wheels watch is on station (as in this case) and advise them to recheck that their gear is down. When push comes to shove, though, it's really up to those at the controls to keep from landing their planes like toboggans. Incorrectly performing PCL steps can lead to much more than just a slip of the mind!

LT Darrell Smith, USN (left) with 2d Lt Mark Marek, USMC.

LT Darrell Smith, USN
2dLt Mark Marek, USMC
VT-19

THE bird strikes continue! While turning over a checkpoint in west central Alabama during a low-level training mission, LT Darrell Smith, USN, the instructor in the rear seat of a T-2C, looked up and saw several large birds directly in the path of his aircraft. He immediately took control of the T-2C and attempted to climb over the birds. A shattering impact occurred as a large turkey buzzard blasted through the metal frame between the center and port windscreen panels. Both panels disintegrated.

The turkey buzzard penetrated the port panel and struck the student, 2dLt Mark Marek, USMC, on the left shoulder and then ricocheted off LT Smith's left shoulder, mask, and visor. Visibility was severely restricted, as the entire canopy was covered with blood.

Immediately after the impact, LT Smith initiated a zoom climb, realizing that the aircraft had been substantially damaged. After establishing communication with his student and determining that the T-2 was flyable, he turned toward NAS Meridian and declared an emergency.

Because of the shattered windscreen panels and the blood coating the inside of the canopy, LT Smith's field of vision was limited to the gusty hole in the port windscreen. Despite severe windblast, LT Smith was able to return to NAS Meridian and make a normal landing.

The skillful airmanship and professional handling of this emergency by LT Smith and 2dLt Marek combined to save a valuable aircraft.

BRAVO ZULU

CDR Mark Baldy
LT John Morin
ADC Carl Laseman
VP-16

DURING a night P-3C ASW mission, the No. 1 ENGINE FIRE warning light illuminated after 3 hours of flight. The crew was 700 miles from its home base of Bermuda. The PPC, CDR Mark Baldy, secured the No. 1 engine, aborted the mission, and began the 700-mile transit to Bermuda. Two hours later, the No. 2 ENGINE FIRE warning light illuminated and the No. 2 engine was secured.

They descended to 8,500 feet to stabilize the aircraft. Weather conditions were solid IMC with light precipitation, icing, and turbulence. After a Mayday report was transmitted, all crewmembers donned antiexposure suits in anticipation of a possible ditching at sea. The PPC thoroughly briefed procedures for a night ditching.

Due to the extended transit to Bermuda and the need to secure crossfeeding because of the potential fire hazard, a significant fuel imbalance developed between the port and starboard wings. A controllability check revealed that directional control could not be maintained below 180 KIAS in a no-flap configuration with full aileron and rudder applied toward the operating engines.

Upon arrival at Bermuda, they flew a 180-knot GCA using 18 degrees of flaps. To maintain directional control, both pilots had to stay on the controls for maximum aileron and rudder deflection. Touchdown on the 9,600-foot runway occurred at 160 knots at a gross weight of 105,000 pounds. With maximum braking and full reverse thrust on engines 3 and 4, the P-3 stopped with 1,500 feet of runway remaining.

By displaying outstanding judgment and airmanship, with the aid of his copilot, LT John Morin, and flight engineer, ADC Carl Laseman, CDR Baldy saved his crew and aircraft during one of the most serious compound emergencies that can be encountered by a P-3 aircrew. ◄

LT John Morin (left), CDR Mark Baldy (center), and ADC Carl Laseman (right).

The last words on motherhood

By CDR Dan Ryder
Commanding Officer, VA-82

AS if there were an edict that there be a quarterly pronouncement on safety, our functional wing commander has once again gone to press with a first, second-annual, quarterly, semiannual, biweekly (circle one) safety message. Laden with homilies, platitudes, and a lot of earnest worry, he and his safety officer have penned yet another in a line of safetygrams that probably originated in the house of Daedalus.

It is not a mistake that these are known in the fleet as messages of motherhood.

It might be a mistake to dismiss them. Certainly, if the Commodore could predict what the next crisis would be, the next failure, the next accident reagent, he would tell us and we would be safe or at least we would take precautions.

To some extent this works. He warns of snow, icing, and low clouds in the winter. He predicts bird migrations in the spring. He forecasts lengthened takeoff rolls in the summer.

Without relying on linear regression analysis or even standard deviation, he accurately predicts the cause of a surprising percentage of the mishaps we have.

Like Mom, he wants his boys to go out into the world and take it on at full force, yet he's scared to death that we'll speed, wreck the new *Buick,* and perforate our spleens on the steering column.

At least since the rise of Ralph Nader, Mom hasn't had to worry about the engineering of the family car. Our air machines are doing well too, and the airborne accident rate has dwindled in the past few years. The Commodore apparently thinks the airplanes are terrific, too. And just like Mom, he casts a look of true anxiety and says he's really afraid for *us.* He is anxious about the unknown and is not comforted by the probability figures showing someone is likely to screw up. Fifty percent (give or take a nickel) of the major accidents (now termed Class A F/FR mishaps) involve pilot (not aircrew) factors.

He knows it.

I know it.

And so do you.

He's worried you might cause one, while you are cocksure you won't. He thinks you can prevent pilot-error accidents, and you think everyone (else) ought to try.

Perhaps the Commodore's problem is that he's dealing with a bunch of highly-developed split personalities.

I know you just checked the byline and found no Ph.D. near my name, and I freely admit that I flunked bead stringing in Mrs. Stanton's kindergarten, but look who they've recruited.

They looked for guys who didn't (initially) wear glasses, had good hand-to-eye coordination, and who thought it would be a real shot in the butt to whistle around at WARP Factor 6, fly nap-of-the-earth, drop high explosives, shoot guns, smoke drones, etc. They didn't want really stupid guys, and they must have realized that eventually we would conclude that the insurance rates for tailhookers were higher because *Prudential* expects to pay us off more frequently than our "shoe" and "sinker" brothers. Additionally, we were supposed to overlook the flak and make a down-the-throat shot with a *Shrike,* all whilst evading SAMs.

On the flip side of your split personality, you are supposed to be logical, cautious, and smart.

How do you describe this ego which simultaneously shows arrogance, aggressiveness, and self-denial on one hand and self-preservation, scrupulous care, and precision on the other? The ingredients for internal conflict are there in abundance in each of us.

That a large percentage of all accidents involve pilot error shouldn't knock anyone off his chair. It should be anticipated. The pilot is the single critical item we fly to failure. All of the hardware and software that directly involves safety of flight is inspected or replaced at specific intervals. Items with backups or those not considered critical are flown to failure, flown until they break.

Engines – inspected on hourly intervals, changed on hourly cycles determined through statistical analysis.

Flight controls – redundant systems.

Tailhooks – changed based on hits.

Landing gear – changed, inspected based on number of landings.

Gyros – redundant systems.

Pilots – annual physical.

Machines have another advantage: we know the environment they will work in. We know the G, the air-conditioning requirements, the electrical load, and mean time between number of operations a piece of gear can perform before it reaches its endurance limit. If it's an important item, we overengineer it or change it early. We coddle it. If we stretch it beyond the designed limits, take it out of design environment by letting it overheat, land it hard, or let the connectors corrode and it breaks, we are not surprised. Yet we are surprised when a pilot makes an error. Compared to the scrupulous engineering and design of the machines that comprise our aircraft, we know very little about a pilot's outer limits – his ability (or inability) to surge, his threshold of boredom and inattention, his belief in the rules, his belief in himself, his ability to concentrate, his capacity to operate when fatigued. Then there is the ability to be of two minds about personal survival. Is it a gift or a defect?

There is a chain of people and events and material that we forge to launch a sortie, perform a mission, and recover. Unlike any of the mechanical links, the pilot's strength changes from day to day, even minute to minute. In about half the mishaps he is considered a failed link.

How does this bear on the Commodore's motherhood message? I will answer with this anecdote:

A long time ago, when NAS Meridian had only recently risen from the swamp, my wife was waiting for me on a bench in front of the commissary. (This was a special bench, usually occupied by children too unruly to be brought into the commissary.) A local bench resident poked Donna for attention and asked, "Where's your mommy?"

There could have been a fairly complex and very long answer to the question, but Donna, not wanting to go into the Norwegian immigration to Minnesota or the Irish potato famine, said simply, "I'm my own mommy."

The Commodore just can't believe it in our case. He can't believe that we're totally responsible, that we won't waste ourselves. How could he? He's one of us! He's released low, he's oversped the flaps, he's gone past platform at 5,000 feet per minute, he's had vertigo bad enough to throw up, he's spotted the deck, he's failed to concentrate, he's had "no grades" that should have been "cuts," he's dropped a bridge on the second pass. He's probably done it all, *but he's also rejected a million ideas that were worse.*

He grew up with a much tougher mishap rate, yet the proportion of pilot-caused mishaps has remained almost constant. Every time the voice in the back of his head whispers, "Tell them to be careful," he'll do it.

Listen.

And listen for your own voice if you want to become as old as he is. ◄

Get us out! Get us out! Get us out! Get us out!

By LT Colin Sargent

EXPLOSION, slow motion, seat-man separation, one-half swing, darkness, fear, and you're on the ground. So is your RIO. Your parachutes spill whiteness on the wet grass. Way up ahead, the F-14 has stopped, but its engines are still roaring. You run toward the aircraft to secure the engines, and on the way you begin the kind of careful thinking that will ensure you a lifetime of better flying.

After all, while you've still got red money in your veins, the best gamble is to play it safe. You know that now. How did you arrive at this conclusion?

Let's start on the runway. It was dark outside when you set Zone 2 afterburner for takeoff in your F-14A. A commotion of blue and white light appeared behind you, and you alerted your RIO, released the brakes, and advanced power to Zone 5. With the nozzles staging exactly, you performed a smooth Zone 5 takeoff and began a climb into the night sky.

There were a couple of scattered clouds ahead, and as the pine trees and runway lights vanished beneath you, you lifted the gear handle. This was going to be a good hop, just a dozen easy FCLP bounces at nearby NALF Evergreen and then home again.

Relaxed, you wiped out the cockpit.

Barberpoles. What was wrong? There were barberpoles everywhere on your landing gear indexers, and the transition light was still on. The breathing sound in your oxygen mask grew slightly more urgent. Concerned, your RIO broke out the PCL and read procedures for unsafe gear up. Following step by step, you lowered your gear handle and, an instant later, got a beautiful *three down and locked* indication. The ice in your voice started to thaw. Next, the little blue book told you to *land as soon as practical*.

You didn't say anything for a second.

"Even though we have to keep the gear down for the rest of the flight," the RIO broke in, "we can still go to Evergreen for these FCLPs and return dirty."

You hesitated and then agreed. You needed the FCLPs because your squadron was flying out to the carrier the next day.

No problems.

There was a good horizon ahead as you called to Paddles at Evergreen and told him you'd be dirty when entering the pattern. The controlling LSO said that would be fine, so you continued inbound.

Once at Evergreen, your first pass was a heavy waveoff due to some tricky crosswinds, and the LSO informed you that all three gear were looking good. You continued with 11 uneventful touch-and-goes.

Naturally, it was still very dark outside.

In the pattern on the final pass, you informed your RIO that you were going to raise the gear on departure in an attempt to help Maintenance and troubleshoot the system, adding, *"Maybe the bouncing has corrected the problem."* Worried, the RIO questioned this plan:

"Are you sure you want to do that?"

The RIO had good reason to worry. Why take another chance with the one-armed bandit when you had three cherries down and locked, a winning combination for a full-stop landing? You'd already stretched the rules a bit by liberally interpreting "as soon as practical" to include 12 night bounces at NALF Evergreen (when what you probably should have done was turned around, flown home, and called it a night).

After all, the fate of the free world didn't depend on this particular flight.

And to wonder if maybe the bouncing had fixed your gear was downright superstitious, especially when you consider the 25 million dollars of pure science you were flying. Maybe it had, but why risk it?

Curiosity, I guess. The kind that can kill a *Tomcat* and a highly-trained crew.

Irresistibly confident that some airborne troubleshooting

Finally, the bad news solidified - two lemons and a barberpole, an unsafe starboard main gear indication!

and your record as an excellent pilot and LSO could work wonders with any airfoil made of *Plexiglas* and titanium, *you lifted the gear handle.*

The transition light came on and your future spun in front of your eyes. Finally, the bad news solidified – two lemons and a barberpole, an unsafe starboard main gear indication!

You held your breath. Selecting the gear handle down, you waited for the results. The pine trees sped invisibly below. You didn't like this uneasy feeling at all – it was like Las Vegas blurring at 280 knots with showgirls and neon and Robert Goulet singing in the background. Were you going to make it? You'd always considered yourself an extremely conscientious pilot. If only you could get those three cherries back again . . .

No such luck. This time, you had an unsafe port gear down indication. There was nothing left to do but keep trying. Five seconds later, you got an unsafe starboard main gear up and a transition light. You waited 15 seconds and lowered the handle for the last time. Result? The fruits spun, stopping at two cherries, an unsafe port main barberpole, and a transition light.

Dismayed, to say the least, you noticed that your combined hydraulic pressure had slumped to 2,100 psi from its original 3,000 and the bidirectional pump was on. A moment later, combined hydraulic pressure fell to zero and you secured the pump.

Now, at 2056 local, you declared an emergency to NAS Homeplate, informing them of your hydraulic failure and unsafe gear indications. You were flying at 1,500 feet MSL, 5 miles out.

Entering the Delta pattern over the field at 2,000 feet MSL, you continued with combined pressure zero procedures. An F-4 in the landing pattern climbed up with you for a visual check, and the *Phantom* pilot told you that the nose and starboard gear were down but the port gear was still up with its gear doors closed.

You paused a while and then told the F-4 to move away.

Using emergency gear lowering procedures, you blew the gear down. The *Phantom* moved back into close parade for a night flashlight check. Shining a beam on the black alignment tapes on the locking struts, the pilot said that all three gear looked down and the alignment tapes were straight.

"Good luck," he added.

With your loss of hydraulic pressure, you were correctly worried about losing hydraulic control. You told the tower that you wanted to be cleared for a short-field arrested landing.

Next your RIO reminded you that there was no LSO at this field and asked you if you wanted to wait for one. Still worried about loss of control and possible hydraulic fire, you answered, "No, there isn't time for that."

The tower asked the same question and you replied, "Negative."

"Roger," the tower responded, "You're cleared for a straight-in approach."

Extending your hook with the emergency method, you performed the landing checklist and briefed for RIO-initiated command ejection in case you weren't able to "grease it on" successfully with a very slow rate of descent.

Flying in the groove, you touched down smooth as silk and short of the wire. The left main gear held for 2 seconds, no more, before the silk ripped and your left main gear collapsed.

One hundred and fifty yards away, the alert crew in the crash truck was watching you. Sparks and a fireball ignited the sky beneath your left wing as you dragged it 2,200 feet down the runway.

Inside the cockpit, you were holding the aircraft on centerline with full right rudder and full right stick, and on hot mike, you kept repeating to the RIO: "Hold on, hold on . . . hold on, hold on . . . hold on, hold . . ."

Then your F-14 swerved violently to the left, and just as you departed the runway, you yelled, "Get us out! Get us out!" to the RIO, who pulled the lower ejection handle.

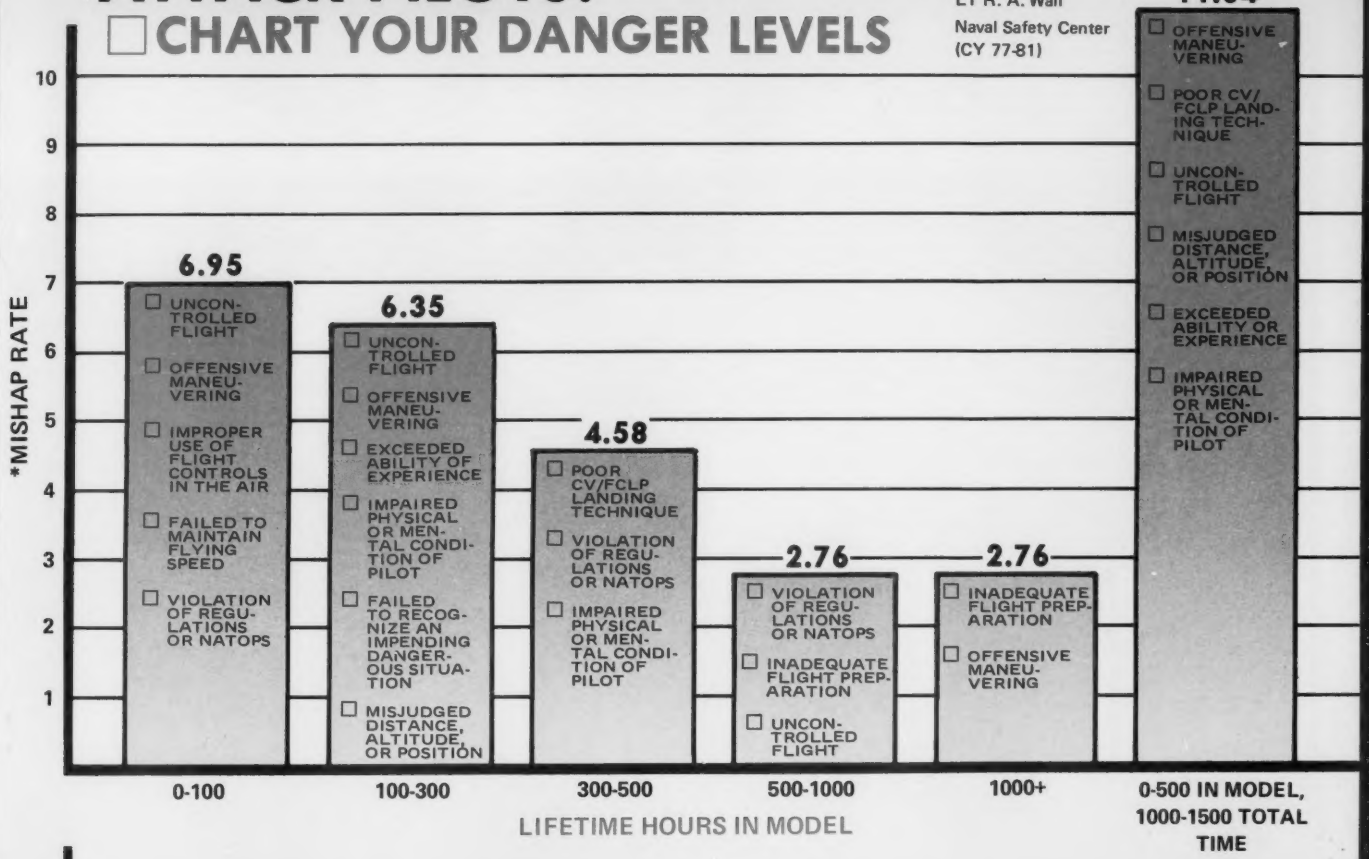
Explosion, slow motion, seat-man separation, one-half swing, darkness, fear, and you were on the ground. So was your RIO. With your parachute spilling whiteness on the wet grass, you ran toward your aircraft and wound up at the beginning of this article. Your engines are still roaring, but there's no way to bring back this F-14, so you begin the kind of careful thinking that will ensure you a lifetime of better flying.

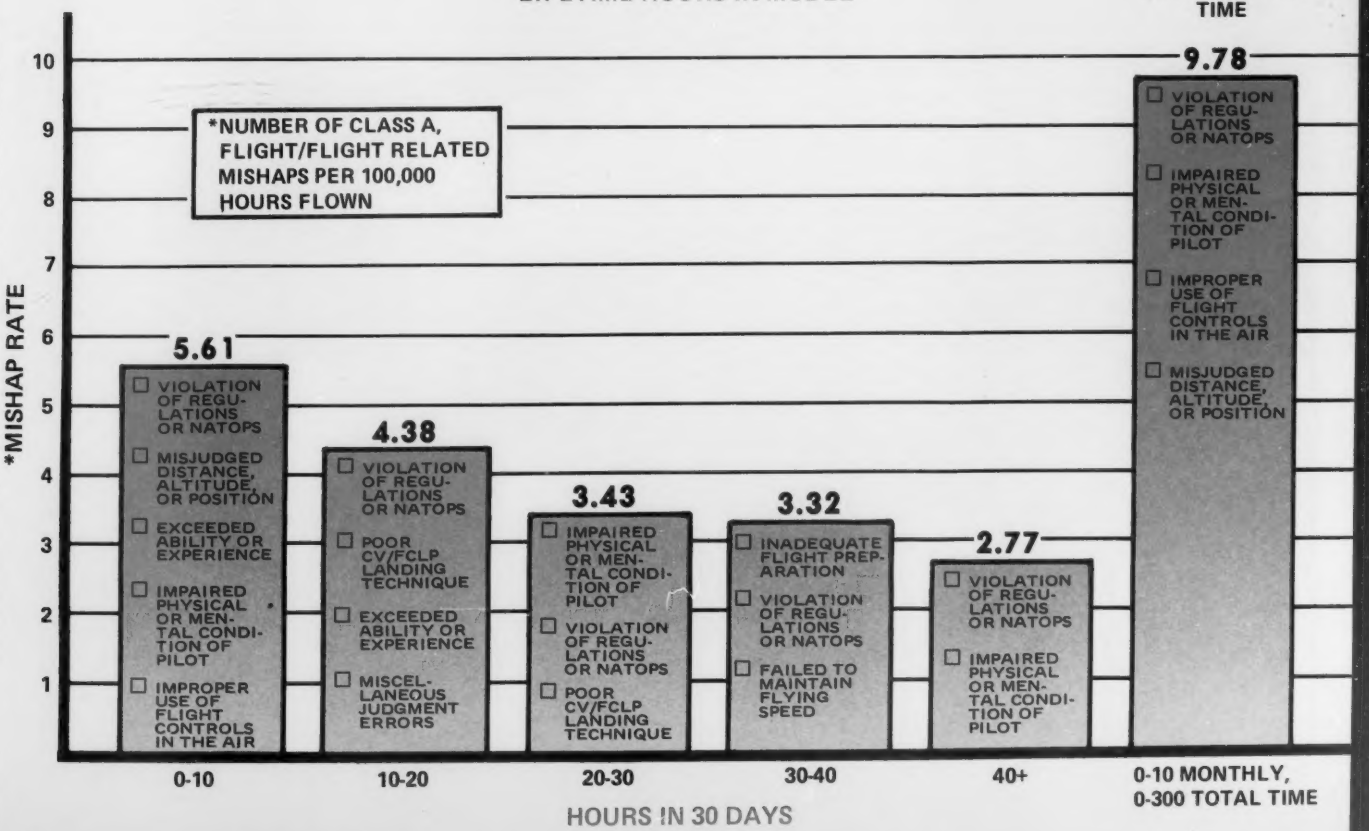
After all, while you've still got red money in your veins, the best gamble is to play it safe. You know that now. How will you use this knowledge? Let's start on the runway . . .

*MISHAP RATE

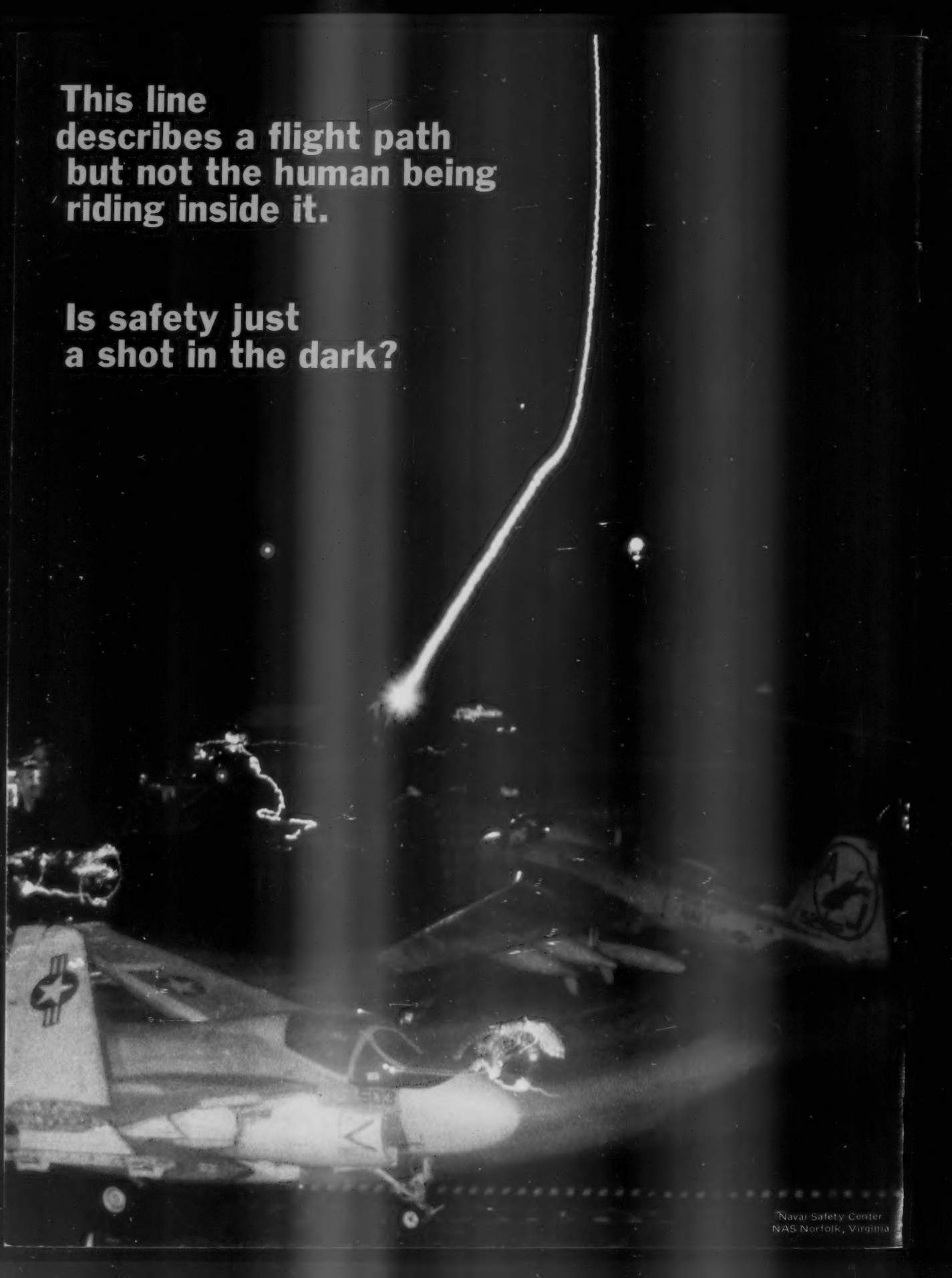
ATTACK PILOTS:
☐ CHART YOUR DANGER LEVELS

Research by
Dr. M. S. Borowsky
LT R. A. Wall
Naval Safety Center
(CY 77-81)





☆U.S. GOVERNMENT PRINTING OFFICE: 1982—539-005/14


This line
describes a flight path
but not the human being
riding inside it.
Is safety just
a shot in the dark?
Naval Safety Center
NAS Norfolk, Virginia